CLOVIS TECHNOLOGY AND SETTLEMENT IN THE AMERICAN SOUTHEAST

A Dissertation

by

ASHLEY MICHELLE SMALLWOOD

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

August 2011

Major Subject: Anthropology

Clovis Technology and Settlement in the American Southeast

CLOVIS TECHNOLOGY AND SETTLEMENT IN THE AMERICAN SOUTHEAST

A Dissertation

by

ASHLEY MICHELLE SMALLWOOD

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Approved by:

Chair of Committee,	Ted Goebel
Committee Members,	Michael Waters
	David Carlson
	Fred Smeins
Head of Department,	Cynthia Werner

August 2011

Major Subject: Anthropology

ABSTRACT

Clovis Technology and Settlement in the American Southeast. (August 2011)

Ashley Michelle Smallwood, B.A., Texas A&M University; M.A., Texas A&M University

Chair of Advisory Committee: Dr. Ted Goebel

This dissertation presents new data on Clovis site occupation, technological organization, and settlement in the American Southeast. Evidence suggests that traditionally-accepted, western-centric models do not fully explain Clovis technological characteristics and settlement patterns in the region.

The first investigation presents the results of a 40 square meter block excavation on the Topper site (SC) hillside where a buried Clovis assemblage has been recovered. I review the site geomorphology and formation processes to evaluate the context of the Clovis component, characterize the Clovis assemblage and the horizontal distribution of artifacts to understand how the Clovis occupants used this portion of the site, and compare these excavation results to the rest of the archaeological record at Topper to discuss the general nature of the Clovis occupation there.

I next focus on the 174 bifaces from Topper to understand biface production. 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 but created a biface assemblage with greater flexibility in design than documented at most other Clovis sites. Clovis groups adapted to local resource conditions and adjusted the organization of their technology accordingly.

In my final investigation, I analyze southeastern Clovis point data and biface assemblages from Carson-Conn-Short (TN), Topper, and Williamson (VA) to test the technological implications of Robert Kelly and Lawrence Todd’s high-technology-forager model and David Anderson’s staging-area model. Significant subregional variation exists in Clovis biface systems, such as differences in point morphology and the tempo of biface reduction. This variation suggests the subregions represent disparate populations who distinctly altered aspects of their technology but maintained fundamental elements of the Clovis tradition.

Ultimately, I demonstrate there was greater variability in Clovis behavior across America. My site-level and regional-level analyses show that the Clovis record in the Southeast is not ephemeral, nor is it identical to Clovis in the West. Instead, Clovis populations in the Southeast intensively occupied procurement camps, adjusted their biface technology with the habitual use of resources, settled into increasingly disparate subregions, and restructured the process of Clovis biface production while maintaining strong affinities to the original Clovis template. Recognizing regional variation in the archaeological record is key to understanding the complexities of Clovis origins and dispersal.

DEDICATION

To Tom, for everything.

ACKNOWLEDGEMENTS

This research was supported by the Archaeology program at the National Science Foundation (grant 078592789). I would like to thank Albert Goodyear and Tom Pertierra of SEPAS Inc. associated with the South Carolina Institute of Archaeology for the opportunity to work at Topper. All the dedicated Topper volunteers, especially Joan and Ernie Plummer, Ann and Bill Covington, DuVal Lawrence, Connie White, Glen Bower, Terry Hines, Carol Reid, Bill Lyles, and John and Allison Simpson, were some of the most wonderful and enthusiastic folks to work with, and I truly thank them for all the hard work.

I thank John Broster, Mark Norton, and Mike Moore of the Tennessee Division of Archaeology, Dennis Stanford and Pegi Jodry of the Smithsonian Institution, Curtis Moyer of the College of William and Mary, and Rodney and Mary Ann Peck of North Carolina for allowing me to study their collections and offering their time and guidance in the process. I appreciate David Anderson and Randy Daniel for their help using PIDBA and thoughtful comments and guidance through the proposal and publication process. They, as well as Goodyear, are certainly southeastern archaeologists to look up to.

Special thanks to Shane Miller who is an amazing research partner, field buddy, and life-long friend. Thanks go to Derek Anderson, Erik Johanson, Doug Sain, Adam Russell, Sarah Walters, Katie Haralson, and Suhani and Riddhi Daftary for help their with excavation, photography, and data collection. Thanks to Charlotte Pevny for being a mentor and best friend. I thank Heather Smith, John Blong, Kelly Graf, and Jesse Tune for entertaining me with conversations of the Paleoindian sort. Lauren Butaric and Keely Carlson gave me mental breaks when I needed them. My mother and sister are two wonderful ladies who have taught me the importance of strength and determination in life.

I also thank my doctoral committee members, Mike Waters and David Carlson, for their years of advice and input. Ted Goebel provided invaluable guidance throughout the course of this research. I appreciate all the opportunities I was provided as a student of the Center for the Study of the First Americans.

Finally, I want to thank Thomas Jennings for helping me work through many of these ideas and reminding me to laugh. Tom, thanks for everything you do every day. I think you are great.

TABLE OF CONTENTS

LIST OF FIGURES

Page

LIST OF TABLES

Page

CHAPTER I

INTRODUCTION

Edgar B. Howard’s visit to the Blackwater Draw site in Clovis, New Mexico in 1932 marked the beginning of decades of archaeological work. In the spring of 1933, Howard’s excavation crew found fluted lanceolate points, distinct from points found at the Folsom site, in direct association with the remains of extinct elephant and bison (Figgins 1933; Howard 1933:524). Since this initial discovery, the definition and characterization of the Clovis techno-complex have been developing and expanding.

Clovis became recognized for its characteristic bifacial point. A type defined by Wormington (1957:263) as a lanceolate-shaped point with flutes that originate at the base and extend no more than half way up to the tip. With the discovery of additional Clovis sites throughout the Plains, Sellards (1952) offered a broader definition of the Clovis complex, which he termed the Llano complex. The proposed Llano toolkit included Clovis points, bone implements, hammer stones, smaller non-fluted points, and scrapers. Other hints of important technological traits were also emerging. In 1963, Green (1963) was the first to link blade production to Clovis people, and he highlighted the importance of a unique behavior known as caching. Yet, early Clovis technological studies focused on descriptions of finished Clovis points.

This dissertation follows the style of *American Antiquity*.

Early definitions of the timing of the Clovis period hinged on the deposition and association of Clovis points with the remains of extinct Pleistocene megafauna, and at Blackwater Draw, Clovis points were found *in situ* stratigraphically below deposits with Folsom points, proving the antiquity of the Clovis archaeological record (Sellards 1952). The earliest explanation of the process of Clovis migration into North America was based on the geological evidence of a land bridge between Siberia and Alaska (Meltzer 2009). After the work of Canadian geologists, Howard and Antevs predicted that the first Clovis colonizers entered North America sometime between 20,000 and 15,000 years ago over the Bering Strait and through an ice-free corridor into the Great Plains (Meltzer 2009). In 1964, C. Vance Haynes (1964:1411) reported the first radiocarbon ages from five stratigraphically-secure Clovis sites in the Plains and Southwest. His evaluation reduced this time range to between 11,500 and 11,000 radiocarbon years before present (yr B.P.).

The repeated associations of Clovis points and extinct Pleistocene megafauna from kill sites shaped early perceptions of Clovis adaptations (Haynes 1964; Wormington 1957), and Clovis people were described by Sellards (1952:17) as “the elephant hunters.” To Martin (1973), hunting not only characterized Clovis subsistence, but it also explained Clovis colonization. Mosimann and Martin’s (1975) Wave-of-Advance simulation model proposed that Clovis big-game hunters explosively spread southward into the Americas leading to the demise of Pleistocene megafauna through overkill. This was the first Clovis model to address the nature of colonization on a continental scale.

These seminal studies formed the foundations of Clovis archaeological research. Since the 1980s research of the Clovis complex has greatly intensified. The discovery of new sites and the refinement of dating, sourcing, excavation, and analytical techniques have led to new emerging definitions of the organization of Clovis technology, the timing of the Clovis period, and the complexities of Clovis lifeways.

Significant advances in Clovis lithic studies began with the experimental work of Crabtree (1972), Sollberger (1977), and Callahan (1979). Their replicative experiments shifted the focus from finished point form and typology to a more thorough understanding of Paleoindian reduction techniques. Specifically, Callahan's (1979) general description of the process of biface production illustrated aspects of technology now considered unique to the Clovis complex (Bradley et al. 2010). Based on artifact assemblages from the High Plains, Bradley (1993) provided detailed descriptions of Clovis biface production and highlighted the importance of two distinct Clovis thinning techniques known as overshot flaking and fluting. Other site–level analyses by Morrow (1996) and Huckell (2007) demonstrated the prevalence of these diagnostic manufacturing strategies in Clovis biface assemblages throughout North America. Likewise, Collins (1999) brought blade production to the forefront, and his work has shown that blade technology is also a Clovis diagnostic. Still, tool assemblages from sites in the West and southern Plains continue to be the benchmarks for definitions of tool forms and interpretations of technology characteristic of "classic" Clovis.

Building on the work of Haynes (1964), Waters and Stafford (2007) redated 11 Clovis sites using modern purification techniques and redefined the age Clovis to a narrower time range between 11,050 and 10,800 radiocarbon years before present. When calibrated to calendar years, they conclude Clovis flourished for a period of 200 to 400 years, and with this new time span and growing archaeological evidence (Joyce 2006; Waters et al. 2011), they suggest Clovis does not represent the earliest colonizers of the Americas. In the most recent model of human dispersal into the Americas, Goebel and colleagues (2008) use genetic evidence and the archaeological record to propose that Clovis progenitors entered North America from Beringia sometime after 16,500 years ago. These studies, among others (Dillehay 2009; Pitblado 2011; Waguespack 2007), have shown that the peopling of the Americas was a complex process. Defining the timing of the Clovis period is not only critical to identifying potential pre-Clovis archaeological complexes but is also essential for understanding the process by which Clovis spread throughout the continent.

The ubiquity of Clovis has led many researchers to attempt to explain the peopling process. Generally, two competing perspectives have emerged: traditional models suggest the spread of Clovis was a rapid dispersal fueled by a subsistence strategy focused on mobile big-game (Kelly and Todd 1988; Martin 1973) and alternative models propose Clovis dispersal was a slower-paced, step-wise process influenced by regional resources (Anderson 1990, 1996; Meltzer 2004). These divergent views of the settlement process both still rely greatly on the western Clovis record to establish timing and interpret behavioral patterns of occupation.

With these more current investigations of the Clovis complex, the field has become increasingly more polarized. Some researchers contend that the traditional understandings of Clovis have been confirmed and that we already know much of what there is to know about Clovis (Haynes 2002; Kelly 2003; Prasciunas 2008). Other researchers recognize more variation in the Clovis record and see the need for new models that help explain evidence of regional differences within Clovis (Cannon and Meltzer 2008; Eren 2011; Smith 2011).

Perhaps, it’s all perspective, and to me, that perspective seems to be largely geographically-driven. After decades of research, most of what we know of the Clovis complex is based on the archaeological record from the Plains and Southwest. Of the 11 securely dated Clovis occupations, only three occur east of the Mississippi River, and only one of these, Sloth Hole (FL), occurs in the American Southeast (Hemmings 1999; Waters and Stafford 2007). The lack of chronometric control has affected our understanding of the timing of Clovis in the Southeast, and because of this, the region is often overlooked in considerations of Clovis technology and behavior. The predominance of isolated points and dearth of buried, stratified sites have led some researchers to believe the Clovis occupation was short and ephemeral (Haynes 2002; Meltzer 1988). This dissertation presents results that suggest otherwise. I describe the excavated Clovis assemblage from the Topper site (SC), and then Topper serves as a standard of technology for comparing Clovis assemblages from buried and surface contexts at Carson-Conn-Short (TN) and Williamson (VA). This dissertation is presented as a series of independent chapters. As a whole, the goal of this study is to interpret Clovis technology and settlement with the southeastern perspective.

In Chapter II, I report results of a 40 square meter block excavation at the Topper site in the South Atlantic Coastal Plain. The Clovis assemblage was recovered in a buried component on the Topper hillside, in a context stratigraphically-distinct from overlying Archaic and Woodland components. I describe the Clovis assemblage. I distinguish the informal and formal core technologies and generally characterize the debitage assemblage. I describe the flaked tools, with details of the biface assemblage comprised of bifaces, fluted-point performs, and a finished fluted point and the unifacial flake/core tool assemblage characterized by retouched flakes, side scrapers, end scrapers, and denticulates. Finally, I evaluate the horizontal distribution of the Clovis assemblage to determine if the concentration of lithic artifacts is the accumulation of repeated, indistinguishable quarry events or evidence of distinct, structured activity loci on a workshop floor. Topper is the only excavated and reported Clovis site in the South Atlantic Coastal Plain and one of only two buried, stratified Clovis quarry-related sites in North America. With this, the assemblage at Topper provides useful information to reinterpret the Clovis occupation of the Southeast.

Chapter III is a more detailed analysis of Clovis biface production at Topper. I analyze all Clovis bifaces recovered in excavations at the quarry-related site to reconstruct the process of biface manufacture. I review characteristics of “classic” Clovis biface technology, as defined by experts studying western Clovis sites, to compare how Topper bifaces measure up to these typical Clovis assemblages. In describing the reduction sequence at Topper, I find that Clovis flintknappers did craft some point performs similar to those reported at western sites. They used diagnostic

Clovis thinning strategies as frequently as knappers at the western quarry-related site, and produced bifaces with the standard, similar sizes and shapes as bifaces reported from other sites outside the region. However, it is the evidence of variation in biface production characteristics that is the most compelling indication of the nature of Clovis technological organization in the Southeast. The production of small performs and other types of bifacial tools suggest Clovis people in the region adjusted the bifacial components of their toolkit and adapted to more variability in toolkit design.

Chapter IV is a broad-scale evaluation of Clovis settlement in the region. I assess two dichotomous settlement models, a rapid-dispersal model and a slower-paced dispersal model, using Clovis assemblages from three southeastern sites: Carson-Conn-Short (TN), Topper (SC), and Williamson (VA). Kelly and Todd's (1988) *high-technology forager* model typifies the rapid-dispersal perspective and describes the archaeological expectations of a highly-mobile colonizing population. Under this model, early Paleoindians entered North America pre-adapted with hunting skills that allowed them to shift ranges frequently with Pleistocene fauna, regularly accommodate new territories, and avoid periodic resource stress. With this adaptive response, Paleoindians left behind behaviorally consistent archaeological records, undifferentiated within a region, regardless of the geographic location (Kelly and Todd 1988:235). Early Paleoindians did not settle into a location, nor did they habitually exploit local resources. Occupations were short and redundant, and the organization of activities was standard from site to site. Finally, early Paleoindians were technology-oriented, rather than place-oriented; thus, their toolkits were equipped with bifaces chipped from high-quality raw material designed to be portable, long use-life tools. Fluted projectile points, one of many tools manufactured from bifaces, lacked regional variation and were stylistically consistent across the continent. Alternatively, Anderson’s (1990; 1996) *staging-area* model predicts the nature of early settlement was a slower-paced process, and based on the distribution of artifacts, he proposes that initial colonization of the American Southeast occurred in a step-wise manner. According to this model, early Paleoindians entering the Eastern Woodlands encountered major river valleys, slowed their movement, and settled into the ecologically-rich locations. These locations became staging-areas or settlement nuclei for group aggregation and residence. As population size increased, populations fissioned and dispersed into secondary staging areas. Early Paleoindian groups habitually-used staging-areas and formed discrete populations, leaving behind dense concentrations of artifacts. These concentrations reflect incipient macroband-level organization and the foundations for early cultural regionalization. While the staging-area model does not explicitly outline implications for the early Paleoindian toolkit, it does propose that Paleoindians logistically exploited resources and regional residence allowed them to regularly replenish toolkits. Further, this model predicts stylistic variation emerged as populations discretely settled into different areas of the region. This study analyzes Clovis point data and biface assemblages from Carson-Conn-Short, Topper, and Williamson to test the technological implications of these two models. Significant subregional variation exists in Clovis point morphology and biface production techniques. This presence of heterogeneity suggests the subregions represent distinct groups who uniquely altered aspects of their technology but maintained elements of the Clovis tradition.

Chapter V concludes the dissertation with a brief overview of each chapter. I characterize behavior at a quarry-related occupation, describe the organization of the biface technology, and evaluate Clovis settlement in the region. It is my hope that this dissertation provides useful information for interpreting Clovis technology and settlement in the Southeast.

CHAPTER II

CLOVIS AT TOPPER: AN EVALUATION OF ASSEMBLAGE CONTEXT FORMATION AND SPATIAL ORGANIZATION

Introduction

The Clovis archaeological complex was initially defined based on the deposition and association of Clovis points with the remains of extinct Pleistocene megafauna (Howard 1933; Sellards 1952; Wormington 1957), and at buried sites throughout the Plains and Southwest (Bement and Carter 2010; Figgins 1933; Frison and Todd 1986; Hannus 1985; Haury et al. 1953; Haynes and Huckell 2007; Hester 1972; Holliday et al. 1994; Johnson 1987; Leonhardy 1966) the characteristic bifacial fluted point has been found in deposits dating between 11,050 to 10,800 radiocarbon years before present (Waters and Stafford 2007). With the secure contexts of western Clovis sites, archaeologists have characterized the Clovis complex by a suite of technological characteristics, including the presence of Clovis fluted points, bifacial point preforms, and bifacial cores, blades and blade cores, modified flakes, and the rare presence of bone and ivory tools (Bradley et al. 2010; Goebel et al. 2008; Haynes 2002; Huckell 2007; Tankersley 2004). Clovis fluted points have been found across mid-latitude North America, but the archaeological record outside of the Plains and Southwest suffers from a dearth of buried sites and chronometric shortcomings. These limitations are perhaps most notable in the American Southeast.

Most of what we know of the early Paleoindian occupation of the Southeast is based on isolated points and surface lithic scatters (Broster and Norton 1992, 1993, 1996; Broster et al. 1994; Freeman et al. 1996; Gramly and Yahnig 1991; Sanders 1990). While these surface records can be used in studies of types and forms and generally show the geographic extent of the Clovis population, little can be said of the nature of site occupation and the organization of technological activities because associated artifacts cannot be directly linked to a Clovis occupation.

The Topper site in the South Atlantic Coastal Plain is a rare example of a buried, stratified site with a rich Clovis component (Figure 1). This paper presents the results of a 40 square meter block excavation on the Topper hillside where a Clovis assemblage has been recovered in setting clearly differentiated from later occupational debris (Figure 2). First, I review the site geomorphology and formation processes to evaluate the context of the Clovis component. Next, I characterize the Clovis archaeological assemblage and the horizontal distribution of artifacts to understand how the Clovis occupants used this portion of the site. Finally, I compare these excavation results to the rest of the archaeological record at Topper to discuss the general nature of the Clovis occupation there. Topper is one of only two known buried, stratified Clovis procurement-related sites in North America (see Bradley et al. 2010; Waters et al. 2011), and thus, this report has important implications for our understanding of the organization of on-site activities at a Clovis “quarry-workshop.”

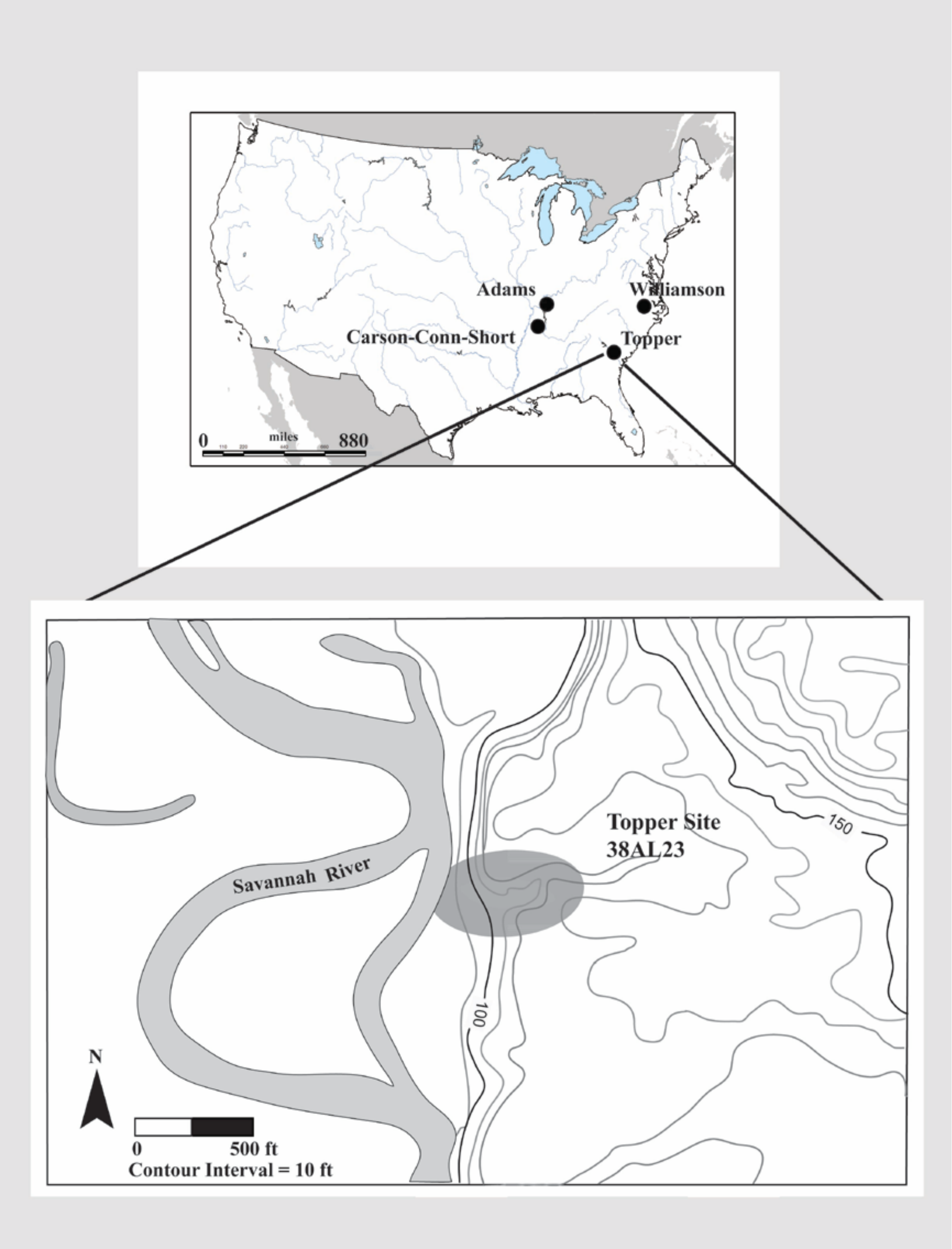


Figure 1. Map of the Topper site along the Savannah River, South Carolina with United States map showing locations of Clovis sites mentioned in this chapter. Contour elevations taken from U.S.G.S Quad 33N/81W.

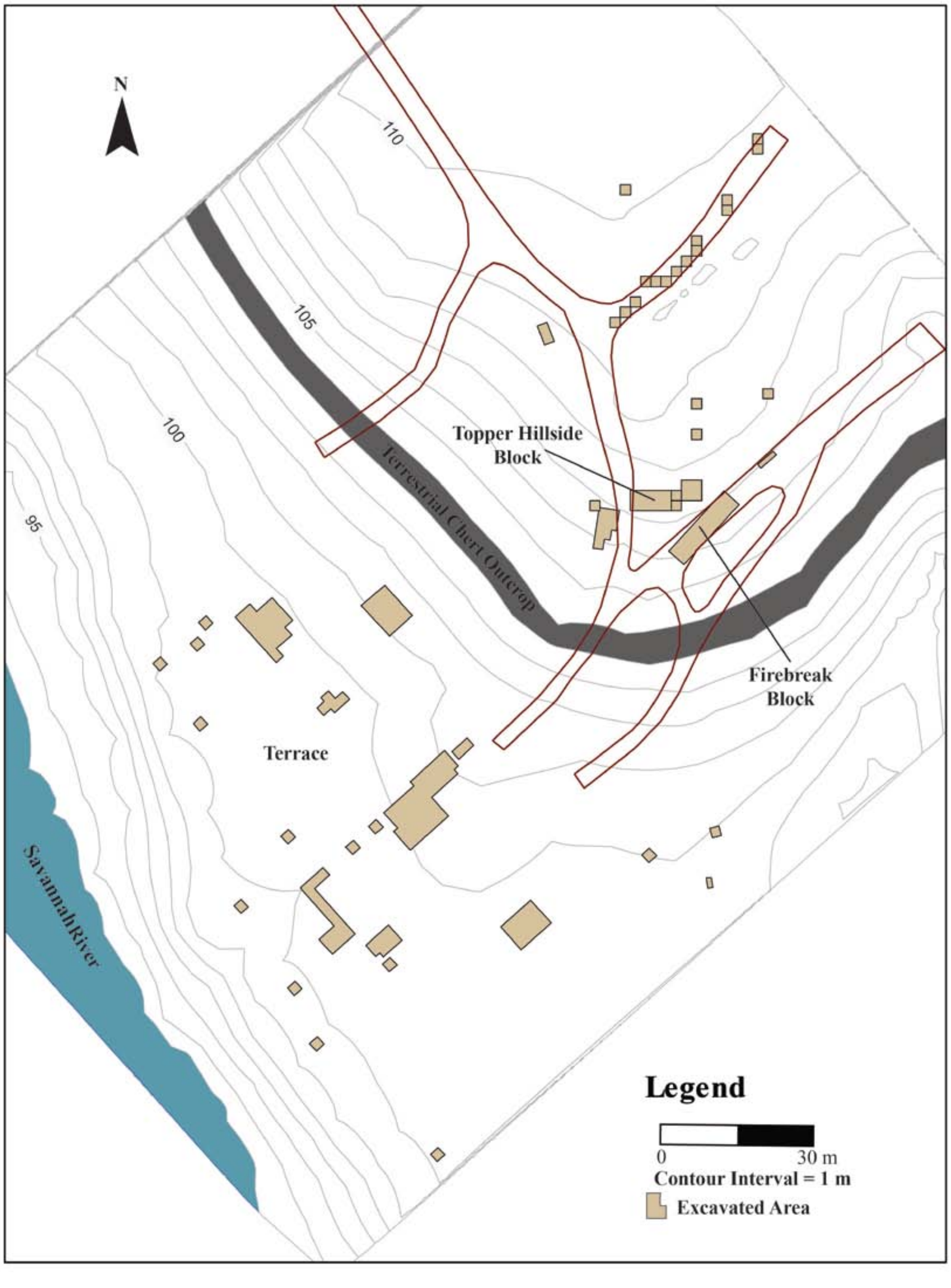


Figure 2. Map of Topper site excavation blocks, showing Topper Hillside block. Elevations based on site datum arbitrarily set at 100 m (Miller 2010; Smallwood and Miller 2009).

Site Location and History

The Topper site is a procurement-related site located in the central Savannah River valley of the Atlantic Coastal Plain (Figure 1). It is situated along a modern chute channel of the Savannah River with a natural outcrop of Allendale Coastal Plain chert of the Flint River Formation. During the late Pleistocene, Topper existed at the intersection of the southern-most limit of a cool and mesic deciduous forest, and the northern-most limit of the warmer, temperate southeastern evergreen forest (Delcourt and Delcourt 1985, 1987; Delcourt et al. 1983; Goodyear et al. 1990). The prehistoric chert source at Topper represents the northern-most extent of the formation. North and east of the quarry, knappable raw material is scarce and limited to quartz sources at the fall-line transition into the Piedmont (Daniel 2001). Clovis hunter-gatherers appear to have been drawn to Topper to procure high-quality chert eroding along a portion of the Coastal Plain uplands and in the Savannah River bottom.

Between 1983 and 1984, A.C. Goodyear surveyed the central Savannah River area and designated Topper as one of 11 potential chert quarry sites in the valley. Initial excavations in 1986 identified an intact Archaic component, and when the site was revisited in 1998, a Clovis component was uncovered in the upper meter of sands (Goodyear and Steffy, 2003). Since 1999, Topper has been extensively excavated, and as of the 2010 field season, the Clovis component covered a total excavated area of 590 m^2. Intact Clovis deposits have been excavated from two main areas at Topper, (1) the terrace adjacent to a chute channel of the Savannah River and (2) the gradually sloping hillside, a portion of Coastal Plain uplands above the chert outcrop (Figure 2) (Goodyear 2005b).

This paper focuses on excavations of a 40-m² block on the Topper hillside (Figure 2). Excavations in this area of the hillside began in 2005 with a 4-m² test. After initial testing revealed a buried Clovis component, the 4-m² block was expanded to 16 m² in the summer of 2006, 32 m² in 2007, and finally 40 m² by the end of 2008. Goodyear directed the Topper field program those years, and I supervised the hillside excavation. Initial test excavations in 2005 were conducted in 2-x-2 m grid squares and 5-cm levels, while all subsequent excavations were conducted in 1-x-1 m unit quadrants following 5-cm levels. All sediment was screened through ¼" and ⅛" mesh. Artifacts > 25 mm in diameter were piece-plotted. One 4 m² unit, N102E38, was not included in micro or macro-level artifact analyses because archived records indicate that a backhoe trench was excavated perpendicular to the north wall. This disturbance was recognizable in the northeastern and northwestern quadrants of this unit. As evidence, in this portion of the unit, a Clovis preform was recovered at ≈ 30 centimeters below surface (cmbs).

Site Geomorphology

Waters et al. (2009) described the depositional history of the landform containing the hillside Clovis assemblage (Figure 3). The site is situated on an inactive alluvial terrace, referred to as T2, of the Savannah River. Three major depositional units have been identified in T2, and chronological control of the geological record is through optically stimulated luminescence. Unit 1, at the base of the exposed profile, is alluvium comprised of a sand and gray silty clayey sand (≈ 2 m thick). Waters et al. (2009) interpreted this to represent a meandering prehistoric river dating before 55,000 years before present (yr B.P.). Unit 2, overlying unit 1, is comprised of a fining-upward sequence of gravels and sands to sandy silty clays (≈ 1.5 m thick). This unit has been interpreted to represent a braided stream environment and is thought to date to before 15,000 yr B.P. After a period of stability, the deposition of unit 3 began, sometime around 13,000 yr B.P. Unit 3 is composed of two subunits, a brown silty sand overlain by a silty sand (≈ 1 m thick). While Waters et al. (2009) did not specifically describe and profile this area of the Topper site, they suggest the upslope sediments of unit 3 were deposited by a combination of eolian and colluvial processes.

In 2005, Foss examined 4 backhoe trenches along the hillside near the 40 m² block (Miller 2010). Based on the profiles exposed in these trenches, the sloping terrace is a sand sheet with an overlying loamy sand horizon that conforms with Waters et al.’s original description for unit 3. Foss described a soil sequence with an Apl horizon (≈ 25 cm) overlying weakly defined E (25-42 cm) and Bw/BC (42-105 cm) horizons (Miller 2010).

Three archaeological components are present on the Topper hillside. Clovis artifacts occur at the base of unit 3, along a slope from 50-85 cm below the modern surface, within the modern B horizon. An Archaic component occurs between 40-50 cm below surface, also in the B horizon. A Woodland component ranges in depth from 20-40 cm below surface in the E horizon. The three components are not stratigraphically distinguishable based on textural or depositional changes in the sediment. As a result, they can only be elevationally segregated. Compounding this is the slope of the hillside, approximately 18 cm vertically per horizontal meter. Consequently, an important part of this research has been to establish the integrity of the Clovis component by plotting its relative relationship to the overlying Archaic and Woodland components and to evaluate whether the Clovis component remains in place or was redeposited colluvially.

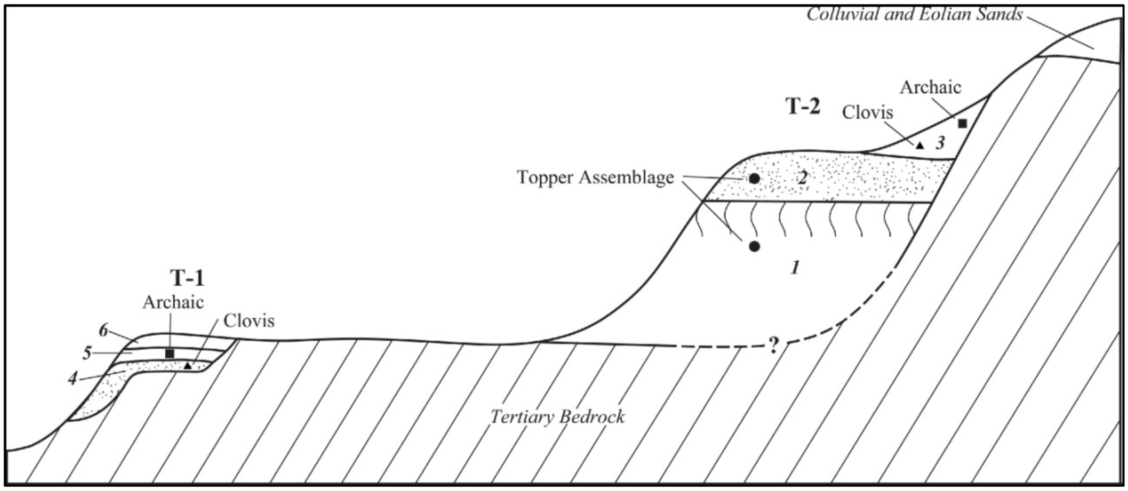


Figure 3. Major stratigraphic units of the Topper site located on terrace 2 (T-2) (Waters et al. 2009).

Site Formation Processes

The integrity of the Clovis floor is first evaluated based on the vertical distribution of artifacts and second based on the orientation of piece-plotted artifacts.

The vertical distribution of diagnostics is shown in (Figure 4). Sand-tempered ceramics were broadly assigned as diagnostics of the Woodland occupation. No diagnostic artifacts were mapped for the Archaic component, and this occupation was loosely defined based on the presence of fire-cracked rock and heat-treated lithics, as well as its relative vertical placement in other excavation blocks on the hillside, where diagnostic Archaic points were found (Miller 2010). Diagnostics representative of the Clovis occupation include a fluted point, bifaces with evidence of overshot and end-thinning removals, overshot flakes, and blades and blade cores (following Bradley et al. 2010). This distribution plots all diagnostics along a collapsed east-to-west profile and does not account for potential perceived dispersion resulting from the south-to-north hillside slope. Despite slight scattering due to the slope, the distribution of Clovis and Woodland diagnostics shows the components are vertically separated by 15-20 cm, and there is no downward displacement of post-Clovis diagnostics. Further, six biface fragments in the Clovis component conjoin (Table 1). The first conjoined biface (Refit Group 1) is nearly 1 meter apart in horizontal distance but only 4 cm in vertical distance. The fragments of the second conjoined biface are only separated horizontally by 7 cm, with no vertical separation (Refit Group 2). The two biface fragments in Refit Group 3 are separated horizontally by 65 cm and vertically by 10 cm. The conjoined artifacts suggest that there may be some vertical displacement within the Clovis component, perhaps caused by the natural slope, but this component is still vertically distinguished from the overlying Archaic and Woodland components.

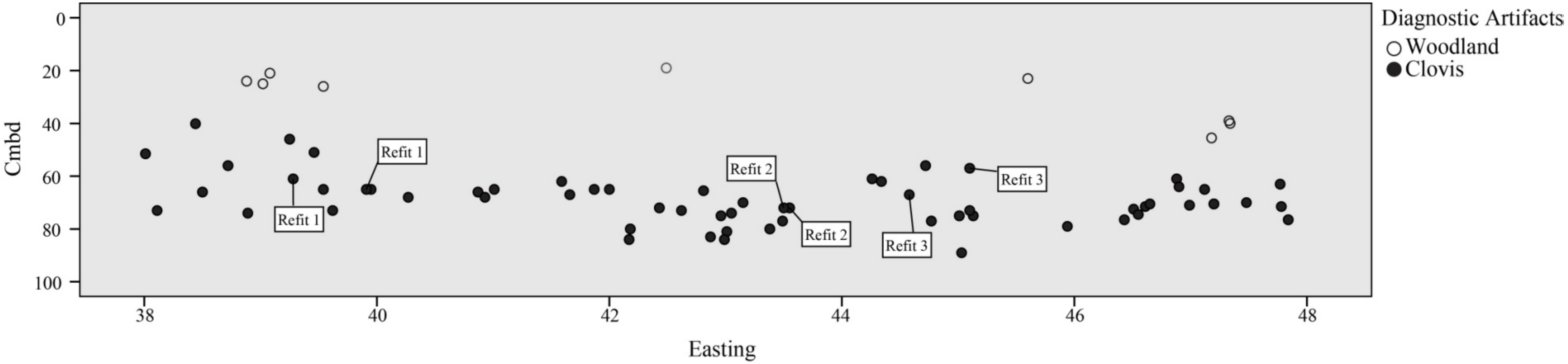


Figure 4. Woodland and Clovis diagnostic artifacts and refit groups.

Table 1. Clovis Biface Fragments That Conjoin.

Refit Group	Artifact	Level	Northing	Easting	Cmbd	Horizontal Distance	Vertical Distance
1	N100E38-3	6	100.65	39.91	61		
	N100E38-96	6	101.35	39.28	65	94.18 cm	4 cm
2	N102E42-72	9	103.38	43.55	72		
	N102E42-73	9	103.32	43.50	72	7.81 cm	0 cm
3	N100E44-1	7	100.78	45.10	57		
	N100E44-1	9	100.39	44.58	67	65.00 cm	10 cm

Based on field observations, lithic artifacts were recorded for the presence or absence of patination. The preliminary hypothesis was that the buried Clovis and Archaic artifacts could be visually distinguished based on the extent of patination and variation in color—a pattern observed in other excavation blocks of the Topper site. Clovis artifacts are highly patinated and white in color, while Archaic artifacts are siliceous, glassy in texture, and pink, likely from heat-treatment. To test this hypothesis and assess if the Clovis and Archaic occupations were vertically distinguished, all micro and macro lithic artifact counts (1/8″and larger) were plotted by units and 5-cm increments. Figure 5 shows that artifact frequencies vary below surface and density spikes are present. In this figure, gray-colored bars represent the percentage of unpatinated lithic artifacts, and black bars represent the percentage of patinated artifacts. In units N100E40, N100E44, N102E40, N102E42, and N102E44, a decrease separates peak levels with high frequencies of patinated artifacts and Clovis diagnostics from the overlying levels with unpantinated artifacts. In these units, the peaks closest to the surface are interpreted as the principal levels of the Woodland and Archaic components, and the deeper peak is reasoned to represent the primary concentration of the Clovis occupation. The decrease in artifact frequency separating the major artifact spikes demonstrates that the two cultural components can be distinguished based on frequencies and the relative percentages of unpatinated and patinated artifacts. While no micro and macro unpatinated artifact data are available for units N100E46 and N102E46, these units illustrate the Clovis occupation spike present in adjacent units. However, interpretations of units N100E42, and N100E38 are more problematic. In unit N100E42 (Figure 5), microdebitage was collected using procedures that varied from later methods applied by the author. Because of the noted inconsistency, this unit was excluded from microdebitage analysis. Unit N100E38 has a unimodal distribution of artifact frequencies with no clear decrease separating occupations. This may be the effect of the modern east-to-west slope; deposits seem to naturally lens out at the western edge of the excavation block. Additionally, the western portion of the block is situated ≈ 50 cm from a modern roadway with regular foot traffic and limited vehicle traffic. This unit required careful analysis of the placement of diagnostics and piece-plotted artifacts along profiles to differentiate the occupations.

Clovis artifacts were distinguished from post-Clovis artifacts based on the vertical placement of diagnostics, separations of frequency spikes, and vertical distributions of patinated artifacts. To further evaluate whether the Woodland and Archaic components could be distinguished from the Clovis component, I mapped all piece-plotted artifacts along segments of the north and east profiles. Along the north profile (Figure 6), the distribution of Clovis artifacts was tightly clustered within a 10-cm-thick-band and vertically separated from the Woodland/Archaic artifacts by approximately 10-15 cm. In a similar pattern, plotted artifacts along the east profile dissecting the excavation block (Figure 7) comprise a relatively tight Clovis component; the majority of the artifacts occur within a 10-cm-thick band.

While there is clear evidence that the Clovis component is vertically distinct from overlying cultural components, the sandy terrace and hillside with an 18 cm/m slope are factors that may have affected the Clovis component. To evaluate whether Clovis artifacts were recovered in place or re-deposited from another context, I measured plunges and trends of piece-plotted artifacts. As an example, I present comparisons of orientations for all Clovis artifacts from two representative units, N100E46 and N102E40. A total of 224 artifacts were analyzed in this process, 142 in N100E46 and 82 in N102E40.

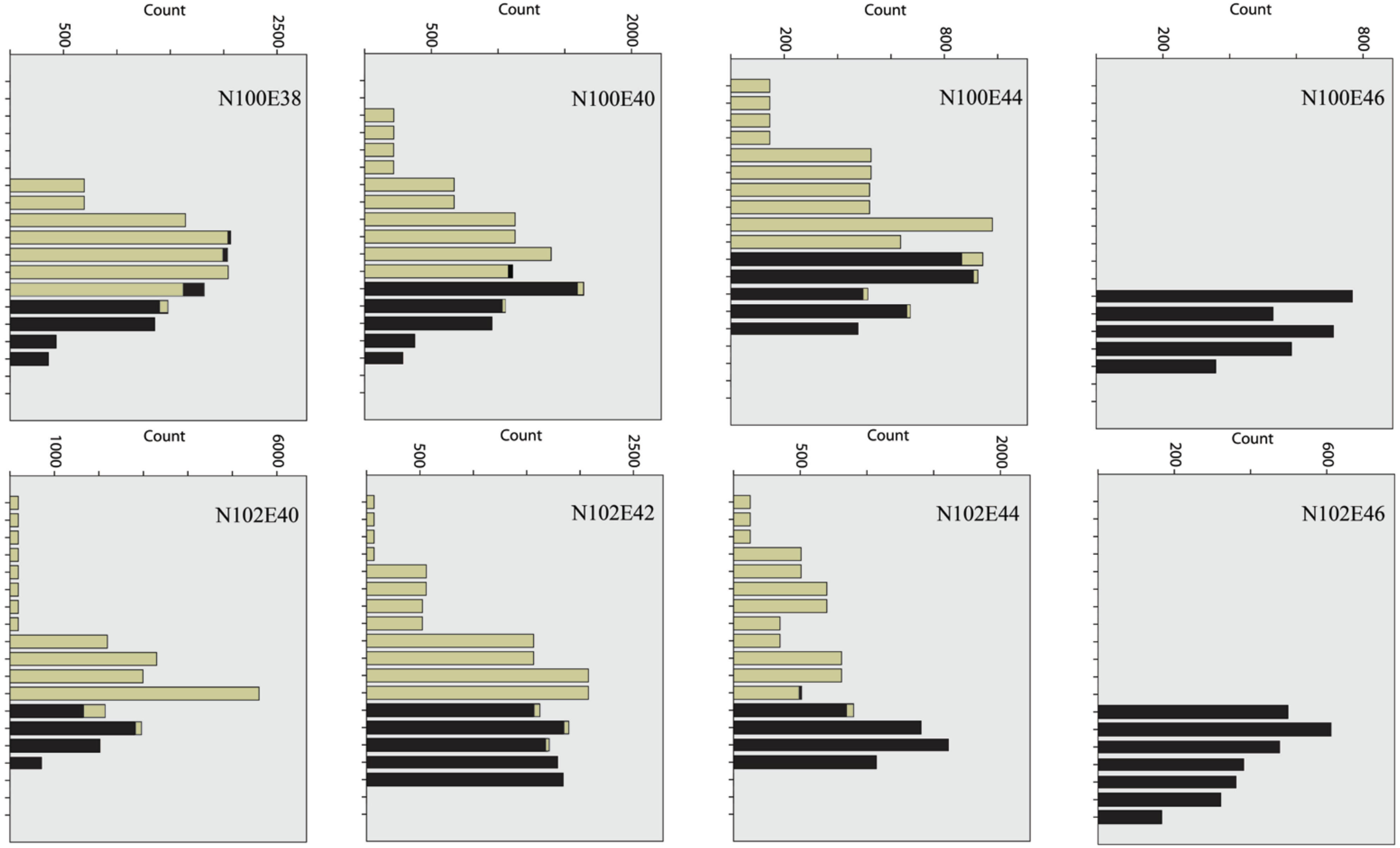


Figure 5. Artifact frequencies by unit and level. Black bars represent percentage of patinated artifacts, and light gray bars represent unpatinated artifacts.

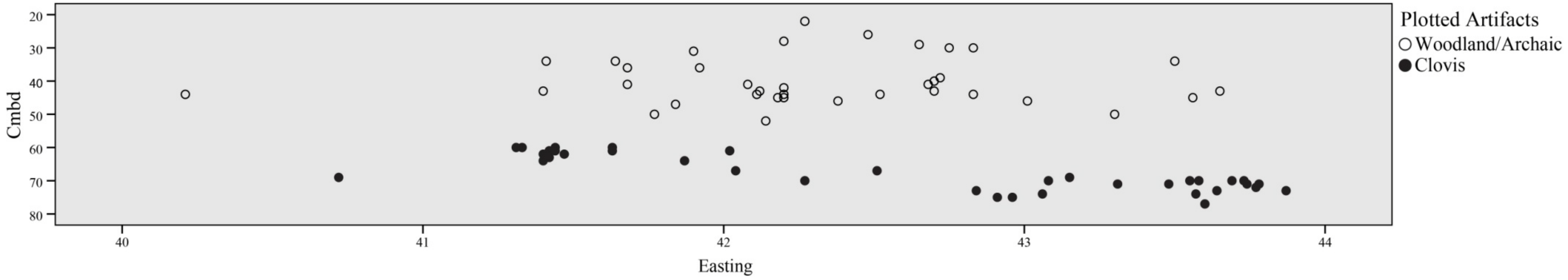


Figure 6. Artifacts plotted along the north profile.

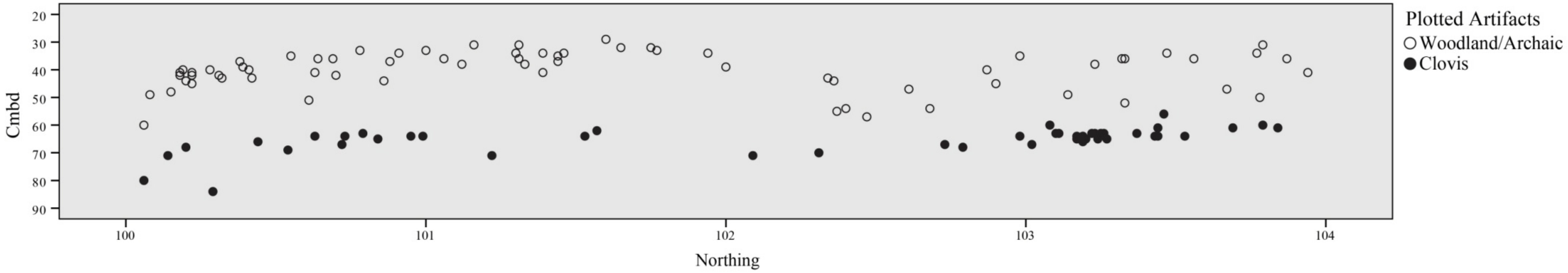


Figure 7. Artifacts plotted along the east profile wall.

For Clovis artifacts in unit N100E46, plunge measurements average less than 30° of horizontal; in other words, artifacts tend to lie nearly flat (Figure 8). Trend measurements do not cluster toward a single orientation as might be expected if artifacts were post-depositionally transported down slope. Instead, there is no clear directional pattern. Artifacts in N102E40 also generally were positioned more flat than upright, with an average plunge of approximately 31° (Figure 9). Also, trends in this unit show no observable pattern of direction. Therefore, the minimal plunges and unpatterned trends of artifacts suggest that the Clovis component was not significantly re-deposited by colluvial processes. They were emplaced on the surface of the gentle slope, and lie close to their original position.

The distribution of artifacts in the Topper hillside block demonstrates that though the deposits lie on a slope, the Clovis component has only been minimally dispersed and remains stratigraphically distinct from Archaic and Woodland deposits. Clovis diagnostics are vertically separated from overlying post-Clovis diagnostics, and there is no downward movement of artifacts assignable to the Archaic and Woodland components. Peaks in vertical artifact densities show that Clovis and Archaic deposits are distinguishable. The vertical distribution of piece-plotted artifacts also shows clear separation of the Clovis component. Finally, plunge and trend analyses demonstrate that Clovis artifacts remain in their primary depositional context.

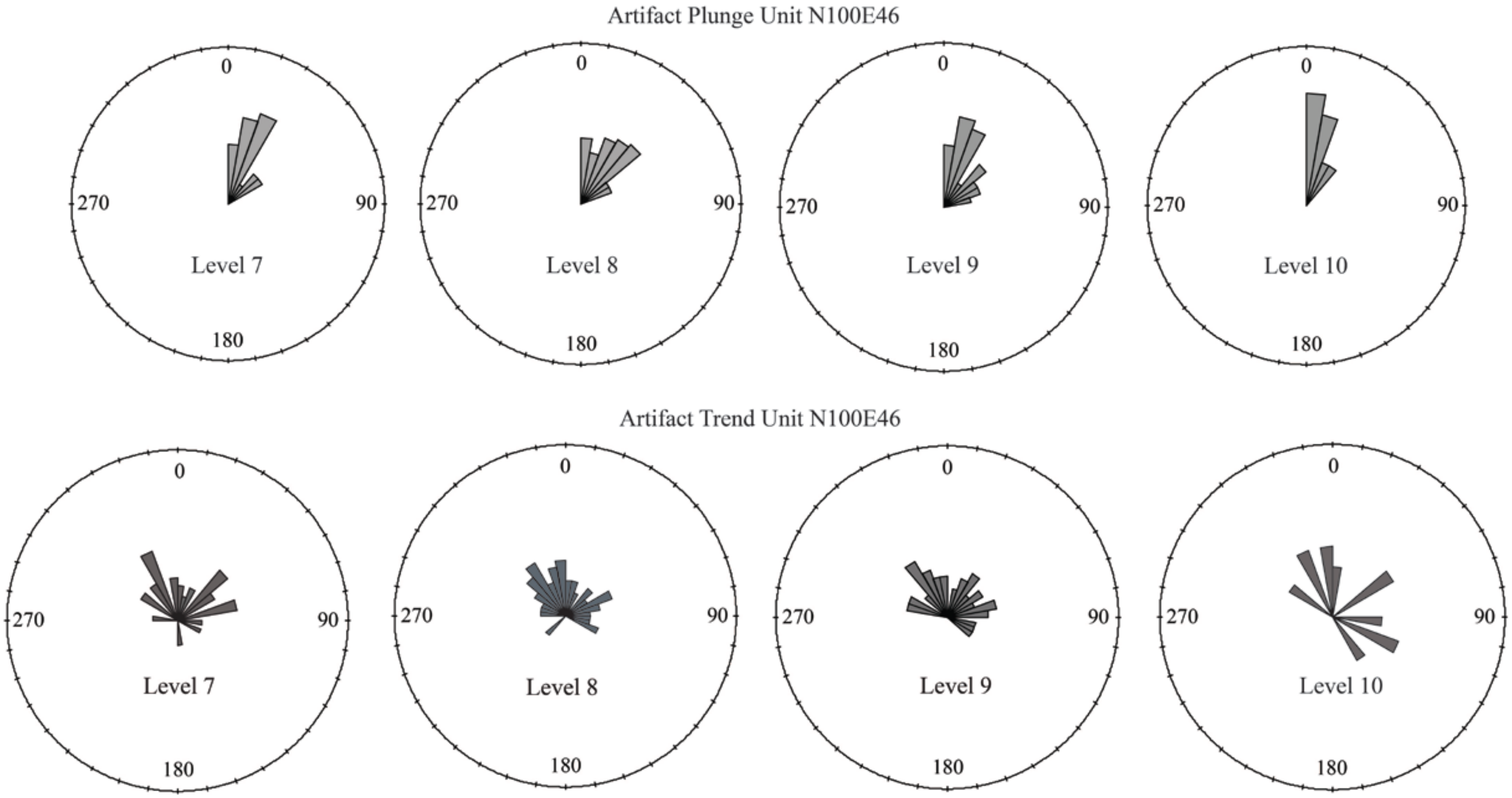


Figure 8. Artifact plunges and trends for unit N100E46.

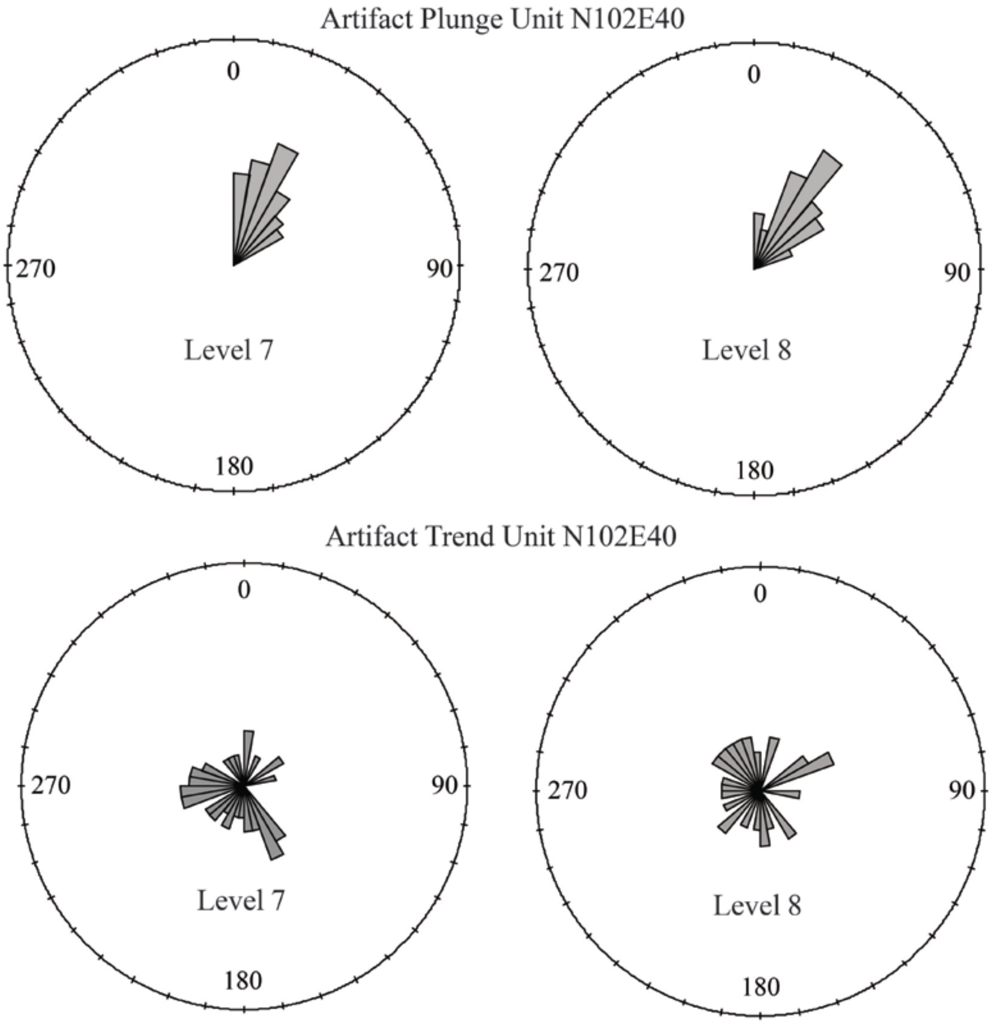


Figure 9. Artifact plunges and trends for unit N102E40.

The Clovis Assemblage

Having established the integrity of the Clovis component on the Topper hillside, I now turn to a description of the Clovis assemblage. Debitage terminology generally follows Andrefsky (2005), and technological terms and definitions of tools are based on Bradley et al. (2010) and Collins and Lohse (2004). Percentages tables and chi-square tests are used to investigate distributions of category variables. Because they are not the focus of this study, the Archaic and Woodland components are not described here.

The Clovis assemblage from the hillside block consists of 37,351 flaked lithic artifacts, including cores (n = 49), macrodebitage (n = 7,455), microdebitage (n = 29,754), chipped stone tools (n = 81), and hammer stones (n = 12). All debitage was size-sorted and counted. Piece-plotted debitage was also characterized by raw material type, cortex amount, chert outcrop type, and technological class.

Raw Materials

The majority (99.995%) of the assemblage is chipped from local Allendale Coastal Plain chert, which outcrops on the hillside 30 meters from the excavation block and in the Savannah River bottom 130 meters from the hillside terrace. Only 2 artifacts are made on non-local raw materials: a fluted point base made of porphyritic rhyolite likely from the Uwharrie Mountains, North Carolina and a flake made of clear quartz crystal, possibly from the Piedmont.

Core Assemblage

The Topper hillside assemblage includes unprepared and prepared core types (Figure 10). Forty-three cores are informally-reduced multidirectional cores that have multiple flat surfaces that served as flake removal platforms. Five cores are formally-prepared blade cores. All 5 are wedge-shaped cores with an acute angled platform used to remove blades from two faces. Finally, the assemblage includes 1 large blade core platform rejuvenation flake with 4 facets around its circumference representing blade removals on the original core face.

Debitage Assemblage

The piece-plotted debitage assemblage is comprised of 882 artifacts. Piece-plotted artifacts (artifacts > 25 mm in diameter) were analyzed based on dorsal cortex amount, and flakes with cortex were further distinguished based on the two chert outcrops. Piece-plotted debitage was also assigned to debitage classes based on platform attributes and the number of dorsal scars. This data was not gathered for provenienced debitage less than 25 mm in diameter recovered in the screens.

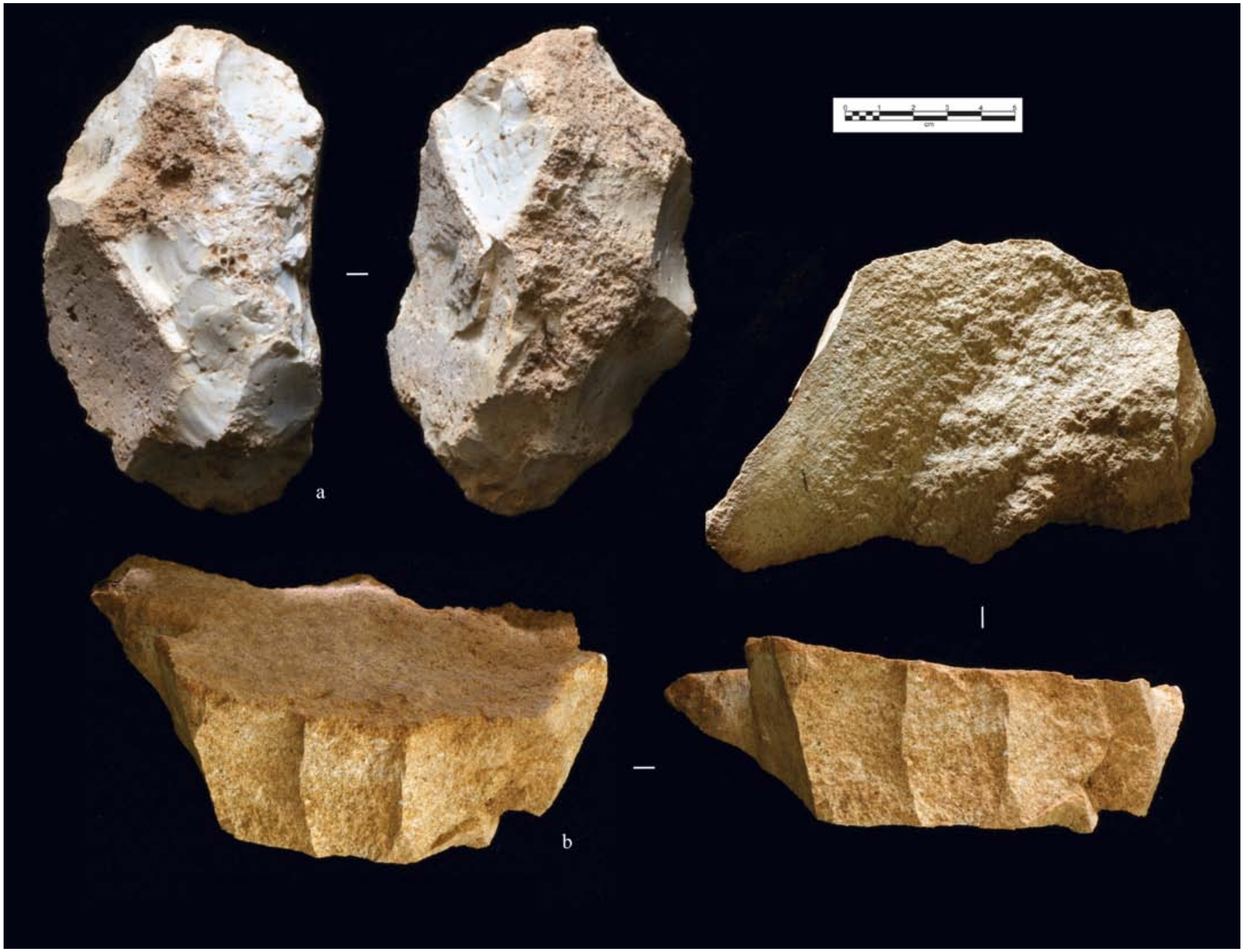


Figure 10. Cores from the Topper hillside: a) amorphous core and b) blade core rejuvenation flake.

Because initial flake removals, removed in the process of testing and reducing a nodule, are presumably larger and cortical, this debitage analysis could be biased toward large flakes with a higher percentage of cortex. With that said, the significant differences in the relative proportions of dorsal cortex amount, outcrop type, and debitage class presented below demonstrate meaningful patterns in the distribution of piece-plotted artifacts.

Dorsal cortex amount serves as an indicator of the relative extremes of the reduction sequence (Andrefsky 2005; Odell 2003). For this analysis, the extent of cortex is based on a basic ordinal scale: 0% cortex coverage (none), 1 to 99% coverage (partial), and 100% cortex coverage (complete). The hillside assemblage includes flakes representing the entire reduction sequence: 241 are flakes have complete cortex dorsal coverage (27.6 %), 254 have partial cortex coverage (29.1 %), and 378 have no cortex (43.3 %) (9 were undetermined) (Figure 11).

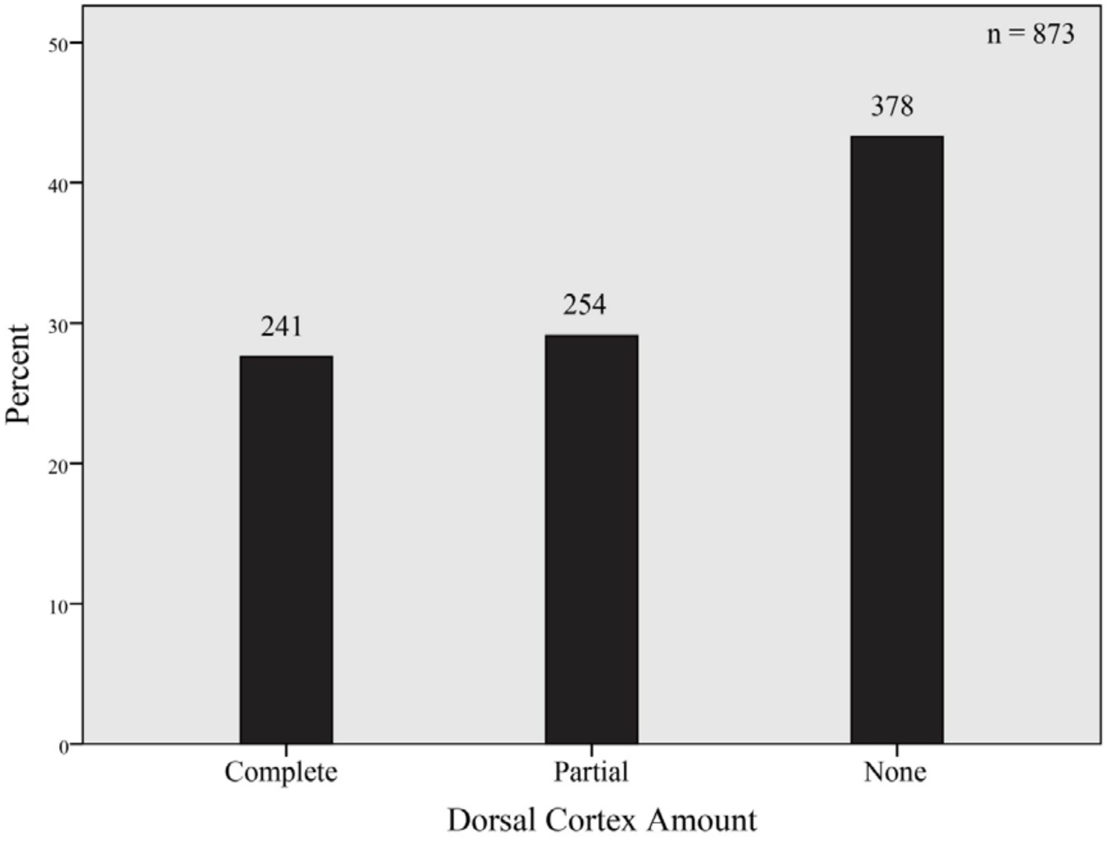


Figure 11. Percentages of dorsal cortex amount with frequencies noted. Note that 9 flakes were undetermined.

As mentioned above, the local Coastal Plain chert erodes from outcrops at two distinct locations at Topper, the hillside escarpment and the river channel, and the two chert sources have visually-distinct cortex characteristics. Based on the hillside debitage assemblage, Clovis people exploited both sources, but chert from the hillside outcrop, situated closest to the block, was exploited relatively more than river cobbles. Only 47 flakes have river chert cortex (9.5 %) and 445 flakes have terrestrial chert cortex (90.3 %). This source may have been favored for its proximity (Figure 12).

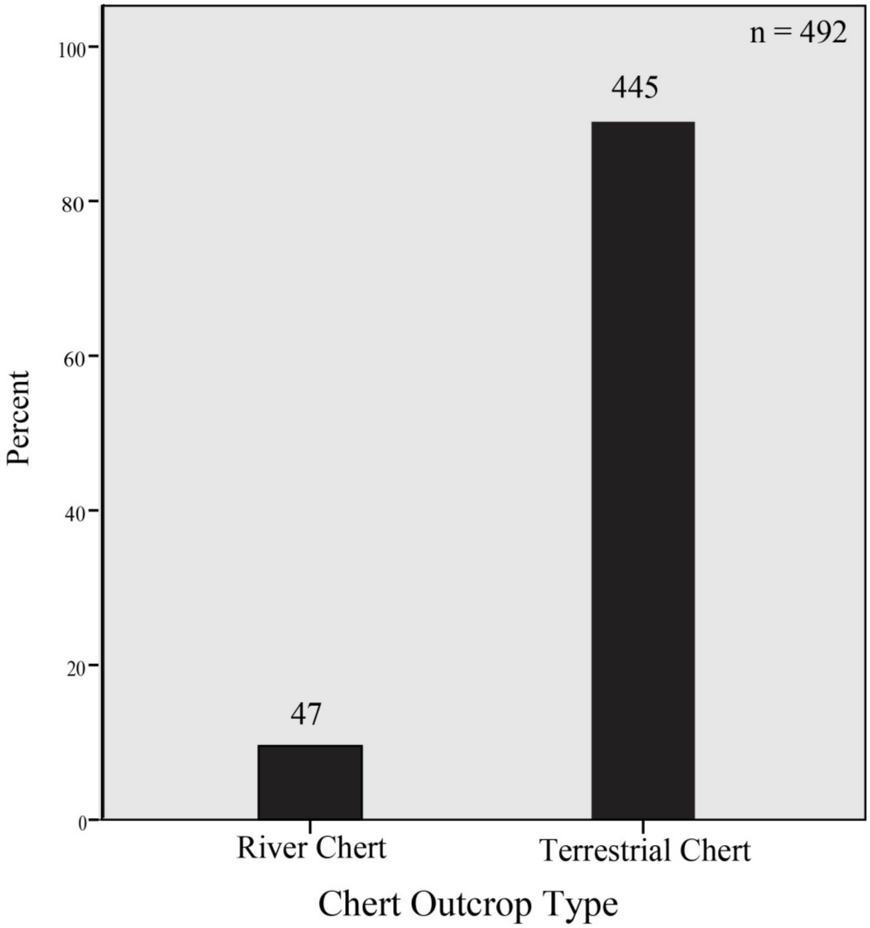


Figure 12. Percentages of chert outcrop type with frequencies noted. Note, only flakes with cortex are included.

Debitage was also evaluated based on a technological typology (Figure 13). The most abundant debitage class is flakes, or flake debris removed in the process of core reduction. Biface thinning flakes are flakes of bifacial retouch with complex striking platforms and multiple dorsal scars (Andrefsky 2005; Crabtree 1972; Frison 1968). Blade-like flakes have length-to-width ratios of 2 to 1 or greater, roughly parallel dorsal flake scars, and simple or dihedral platforms. Shatter is angular debris with no striking platform or bulb of percussion. The assemblage includes 733 flakes (95.1 %), 70 biface thinning flakes (7.9 %), 28 blade-like flakes (3.2 %), and 36 pieces of shatter (4.1 %) (Figure 13). Of the type-able debitage, biface thinning flakes are the most abundant debitage class, indicating biface production was a key technological activity.

The hillside assemblage also includes flake classes distinctive of Clovis technology. There are 7 overshot flakes or lateral flake removals that extended across the face of the biface and removed the opposite bifacial edge (0.8 %) (Figure 13). Of the 7 overshots, 6 are complete and 1 is a distal fragment. Of the complete overshots, 3 have simple platform preparation, 2 have complex platforms, and 1 is a cortical platform. All platforms were prepared with abrasion. Six of the overshot flakes have more than 5 dorsal scars, and the other flake has 4 dorsal scars and remnant river chert cortex on the dorsal surface. Based on these characteristics, overshots were removed throughout the reduction process, when platforms along bifacial edges were simple and complex and biface surfaces were partially cortical and non-cortical.

The 8 blades comprise a smaller portion of the assemblage (0.9 %) (Smallwood et al. 2011), and the low frequency may be due to the material properties of Coastal Plain chert (Figure 14). The lack of large nodules and presence of nodule impurities likely created challenges for blade production (Sain 2011). Of the 8 blades in the hillside block collection, 5 are complete blades, 2 are distal fragments, and 1 is a proximal fragment. Six of these are interior blades and 2 are secondary blades. The nature of individual blade platform preparation can be categorized by two distinct preparation techniques; striking platform remnants are either both isolated and multifaceted (n = 3) or both wide and single-faceted (n = 3). Specifically, 3 are crested blades with diffuse bulbs and marked curvature. None of these blades were secondarily modified.

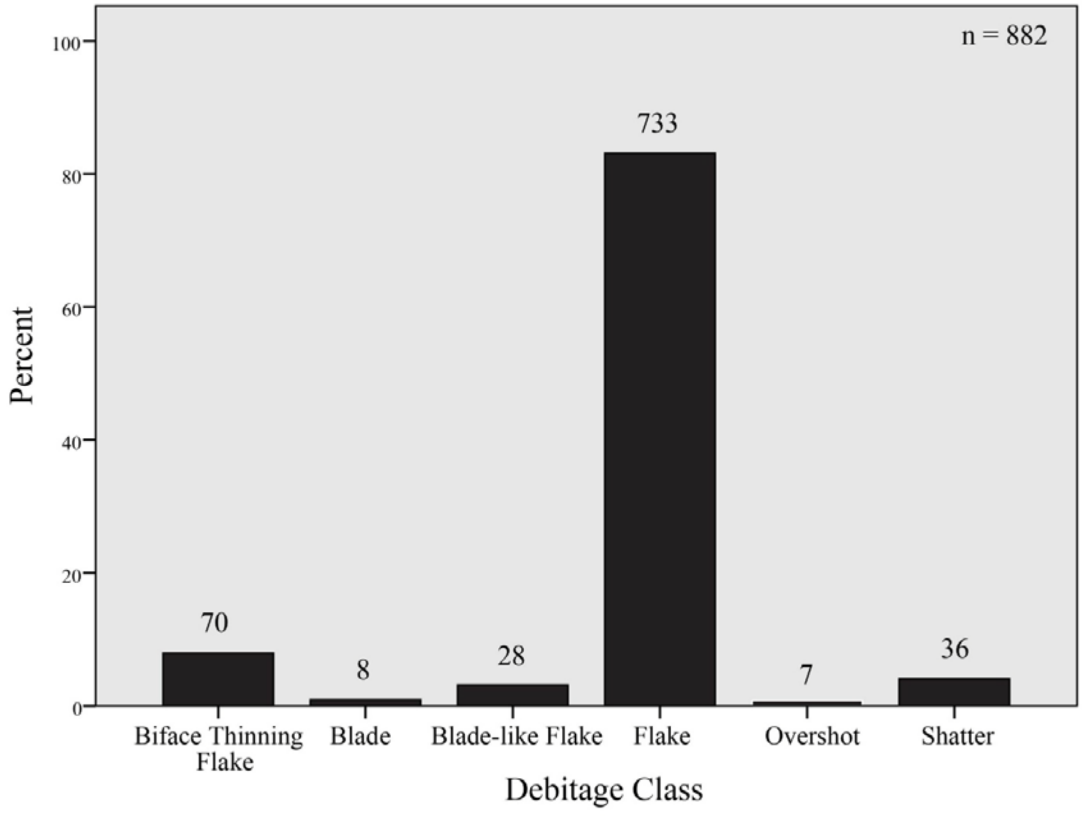


Figure 13. Percentages of debitage classes with frequencies noted.

Figure 14. Clovis blades from the Topper hillside block.

Flaked Tool Assemblage and Hammer Stones

The assemblage of 81 chipped stone tools consists of 37 bifaces, 1 finished point, and 43 flake and core tools. Of the bifaces, 7 are complete and 30 are biface fragments broken and discarded in manufacture (Figure 15). As mentioned, 6 of these biface fragments conjoin to make 3 complete bifaces. All the bifaces are crafted from the local Allendale Coastal Plain chert. The assemblage includes 11 early-stage bifaces, 14 middle-stage bifaces, and 9 late-stage bifaces (Smallwood 2010). Bifaces were crafted on spalls or suitable chert nodules, and thinned using overshot flaking and end thinning. Shaping of Topper bifaces was governed by the intended size and function of the bifacial tool. Twenty-one are lanceolate forms reduced on a projectile-point trajectory with overshot flaking, marginal edge trimming, and multi-stage end-thinning removals. Two of the bifaces are reworked distal fragments likely originally crafted as point preforms and bifacially retouched and rebased (Smallwood and Goodyear 2009). Three bifaces were crafted as bifacial tools other than point preforms; 2 have characteristics of chopping tools (Collins and Hemmings 2005; Smallwood 2010), and 1 has a shape similar to an adze (Morse and Goodyear 1973). The used Clovis fluted-point base was made on quartz-plagioclase-porphyritic rhyolite, extensively used and likely broken in the haft, and discarded in the western portion of the excavation block.

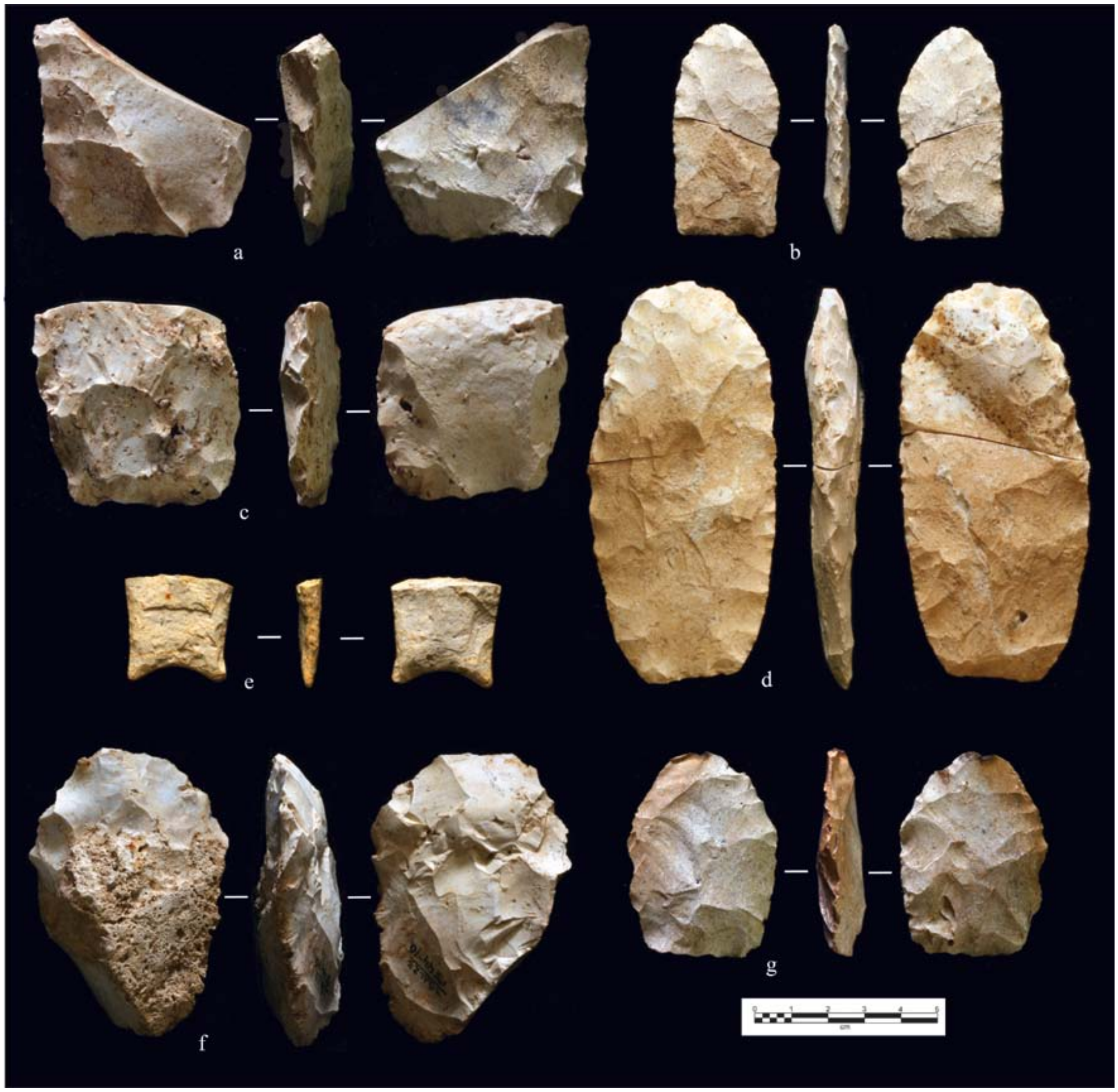


Figure 15. Clovis bifaces from the Topper hillside block: a, c) end-thinned proximals; b,d) refitted point performs; e) rhyolite finished fluted point; f) bifacial adze; and g) reworked point preform distal.

Modified flake and core tools are the most abundant tool classes in the hillside assemblage. Among the 43 tools in the assemblage, there are 41 made on flakes and 2 made on cores. The flake tools include 18 retouched flakes, 10 side scrapers, 6 end scrapers, 5 denticulates, 2 macroscraper/planes, 1 chopper, and 1 graver (Figure 16). Of the retouched flakes, 78% are secondarily retouched on convex edges (n = 14), 17% on straight edges (n = 3), and 5% on concave edges (n = 1); further, 13 are detached from simple flake cores and 5 are modified bifacial thinning flakes. Most of the remaining platform surfaces were simply prepared (n = 5; 28%), but some were cortical (n = 1; 6%), complex (n = 1; 6%), and crushed (n = 1; 6%). Based on this, most appear to be produced on core-reduction flakes, not biface thinning flakes. Finally, the majority of these flakes have minimal retouch, with 72% (n = 13) exhibiting only marginal retouch or nibbling, 17% (n = 3) with scalar flaking, and 11% (n = 2) with stepping.

The production and use of side scrapers were important activities on the Topper hillside. Of the 10 side scrapers, 5 are single-straight sided, 2 are convergent, 2 are single-convex and cortically-backed, and 1 is a single-convex side scraper. Eight of the 10 side scrapers have invasive scalar flaking with retouch scars that terminate from 6 to 18 mm from the tool margin. Further, based on Kuhn’s (1990:590) calculation of Reduction Index (RI), 4 of these side scrapers have RIs greater than 0.70—values experimentally shown by Kuhn to be retouch resulting from greater than five reduction events.

The 6 end scrapers from the Clovis hillside component were made on robust flakes with thick cross-sections. Among these is an end scraper with a lateral margin modified as a spokeshave, as well as 1 circular end scraper and 1 cortically-backed end scraper. The 6 end scrapers have scalar and stepped flaking that terminates 6 to 21 mm

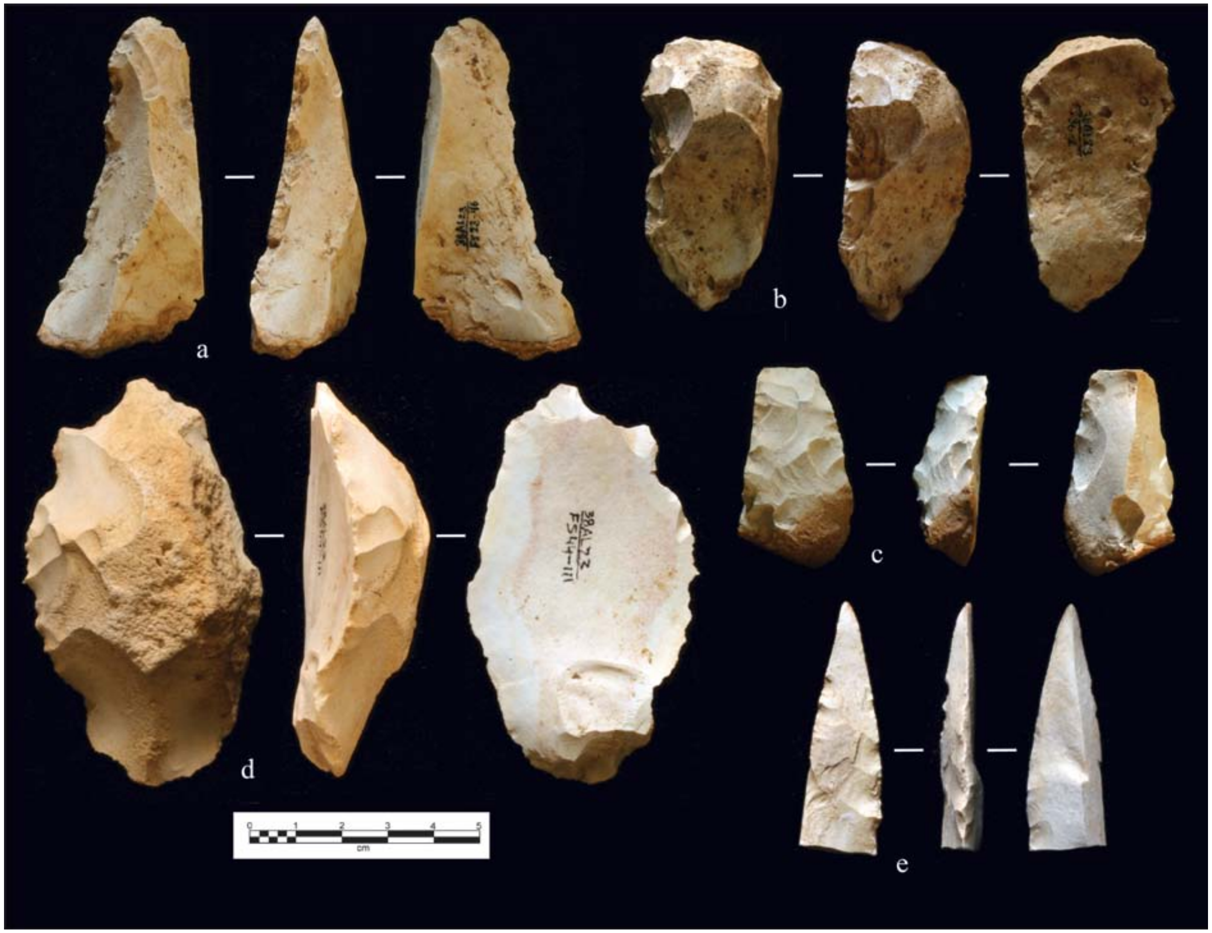


Figure 16. Clovis flake tools from the Topper hillside: a) side scraper, b) end scraper, c) modified flake, d) denticulate, and e) graver.

from the tool margin. Again, 3 of the 6 end scrapers have RI values greater than 0.70, suggesting that these tools were utilized through a series of reduction episodes.

The 5 denticulates are made on flakes with 3 to 6 teeth-like projections isolated along the flake margin. These projections are produced by percussion-flaking, rather than pressure-flaking. Denticulate notch widths range from approximately 8 to 32 mm. Lateral margins are not abraded, but 3 of the 5 have cortical backing.

One single spurred graver was made on a flake. The graver has marginal retouch and nibbling along the convergent margins and visible polish on the tip.

The Topper hillside assemblage also includes 2 artifacts morphologically similar to the macroscraper/planes described in the Clovis assemblage from the Adams site, Kentucky (Figure 14) (Sanders 1990:107). Both macroscraper/planes are made on steeply-keeled flakes with remnant cortex on the dorsal face. These robust tools are approximately 37 and 60 mm thick and weigh 174.3 and 417.6 g. There is scalar flaking and stepping along the squared and convex tool margins. Further, one macroscraper/plane (Figure 17) has crushing along the lateral margin, and 1 has abraded lateral margins and arises.

Also included in the assemblage is 1 chopper. The chopper was crafted on a flake core fragment. The modified core has scalar flaking on the convex working margin and cortical backing.

Besides the flake and core tools described above, there are 12 hammer stones, all on quartz and generally oblong in shape. Their weights range from approximately 8 to 85 grams, and this diversity in hammer stone size suggests that flakes of various sizes were being detached from bifaces and cores.

In summary, the recovery of debitage with dorsal cortex ranging from complete to partial to no cortex amounts suggests the entire reduction sequence is represented, from initial nodule testing to the controlled removal of small, noncortical flakes. Further, the presence of amorphous cores, blade cores, and bifaces, and the byproducts of their manufacture, demonstrates that Clovis knappers were employing three basic reduction trajectories in their tool manufacture. Finally, multiple tool types with evidence of resharpening episodes indicate that both production and use-activities occurred at Topper.

Figure 17. Macroscraper/plane from the Topper hillside.

Horizontal Distribution of Clovis Debitage, Cores and Tools

Evaluating the distributions of debitage, cores and tools helps to define spatial patterning on the Topper hillside. Locational analysis can help interpret the nature of the Clovis occupation and the behaviors associated with the archaeological deposit. Put simply, if artifacts are randomly distributed with no spatial patterns apparent, then the concentration of lithics may represent the accumulation of repeated and indistinguishable quarry events. However, if there are detectable clusters in the data, then they may represent discrete activity loci created during distinct technological activities.

First, the frequencies of microdebitage and macrodebitage were examined to determine if the distributions correlate; in other words, I tested if spatial patterns in microdebitage densities explain patterns in macrodebitage. Figure 18 shows that the linear relationship between microdebitage and macrodebtiage densities by unit does not model the data well ($R^2 = 0.038$; $p = 0.370$), and only less than 1% of the variation is explained by the spatial co-occurrence of micro and macrodebitage. Further, regression analysis of microdebitage unit densities by unit eastings shows that 30% of variation is explained by the east-to-west spatial correlation ($R^2 = 0.344$; $p = 0.003$) (Figure 19). Likewise, when microdebitage counts are randomly plotted by unit, microdebitage densities appear to be higher in the western portion of the block (Figure 20). Based on this scale of analysis, debitage is not uniformly distributed across the block, and there appears to be spatial patterning in the distribution of flake debris.

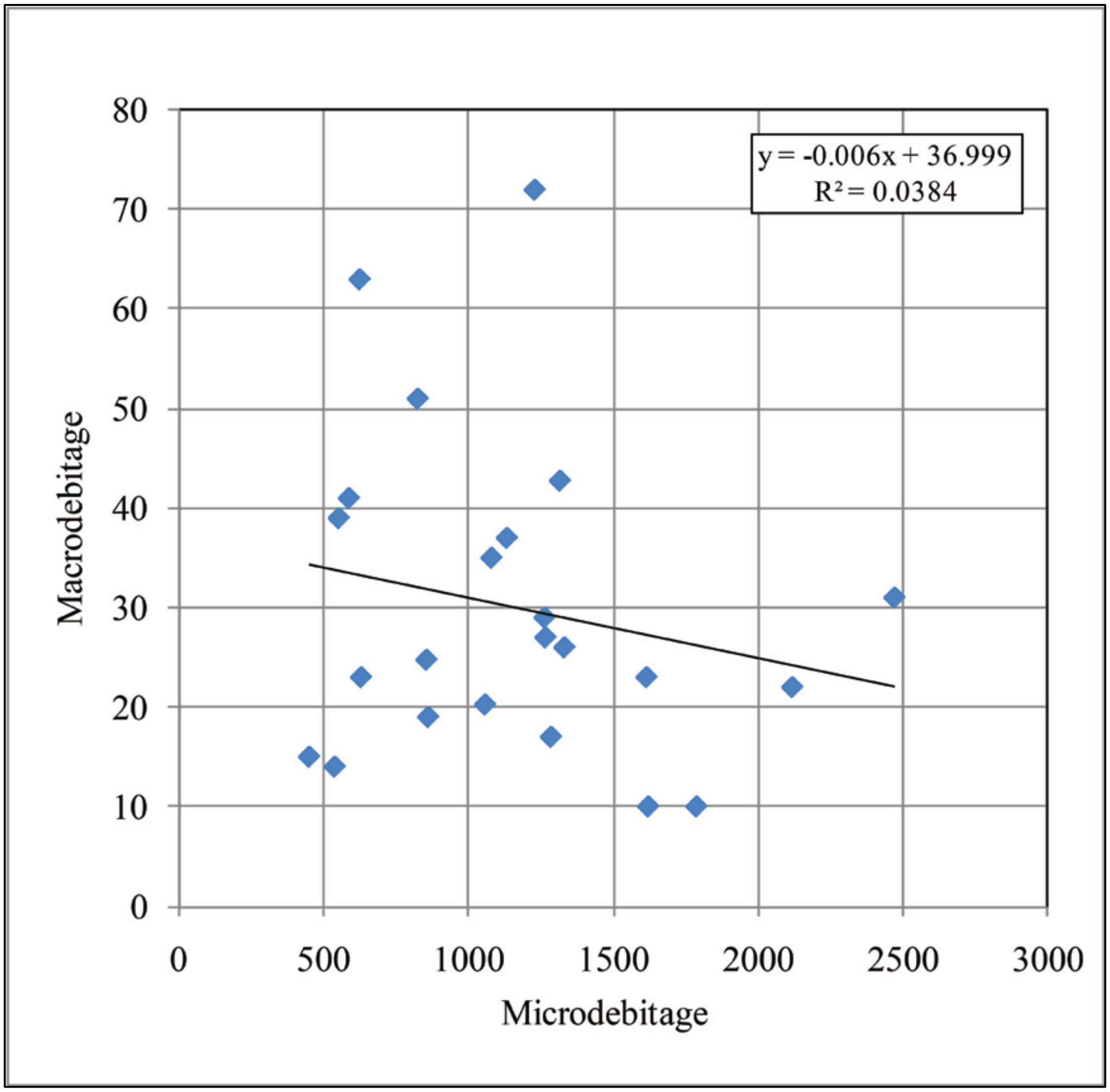


Figure 18. Linear regression of microdebitage and macrodebitage frequencies by units to assess the spatial correlation.

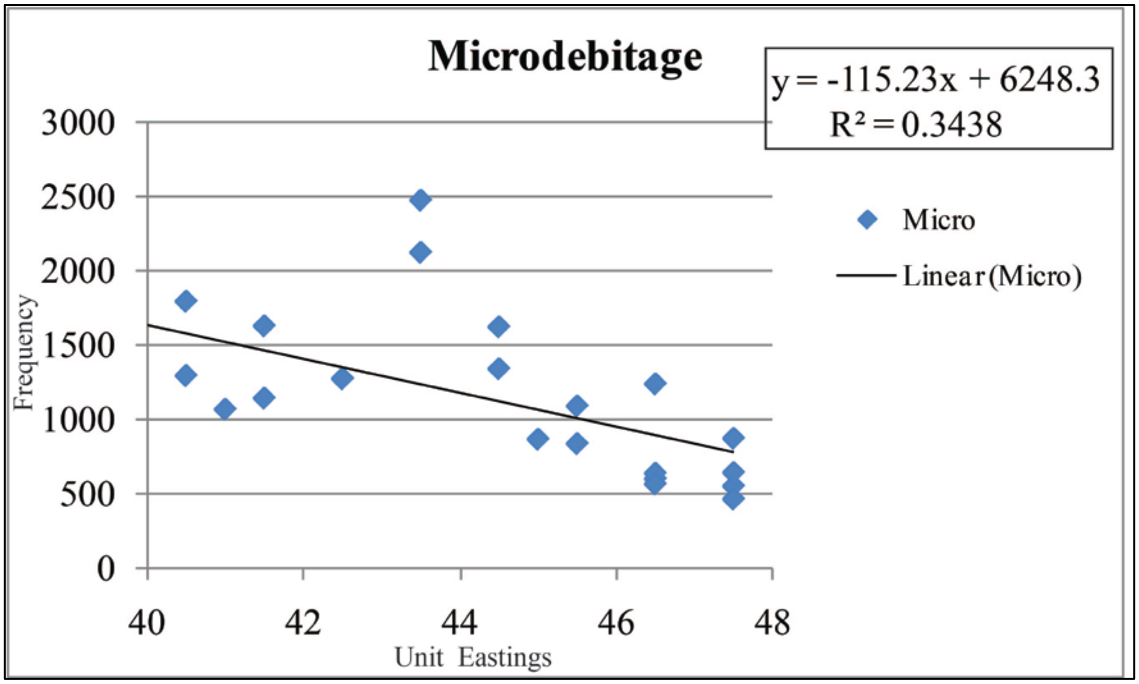


Figure 19. Linear regression of microdebitage frequencies by unit eastings to assess the spatial correlation.

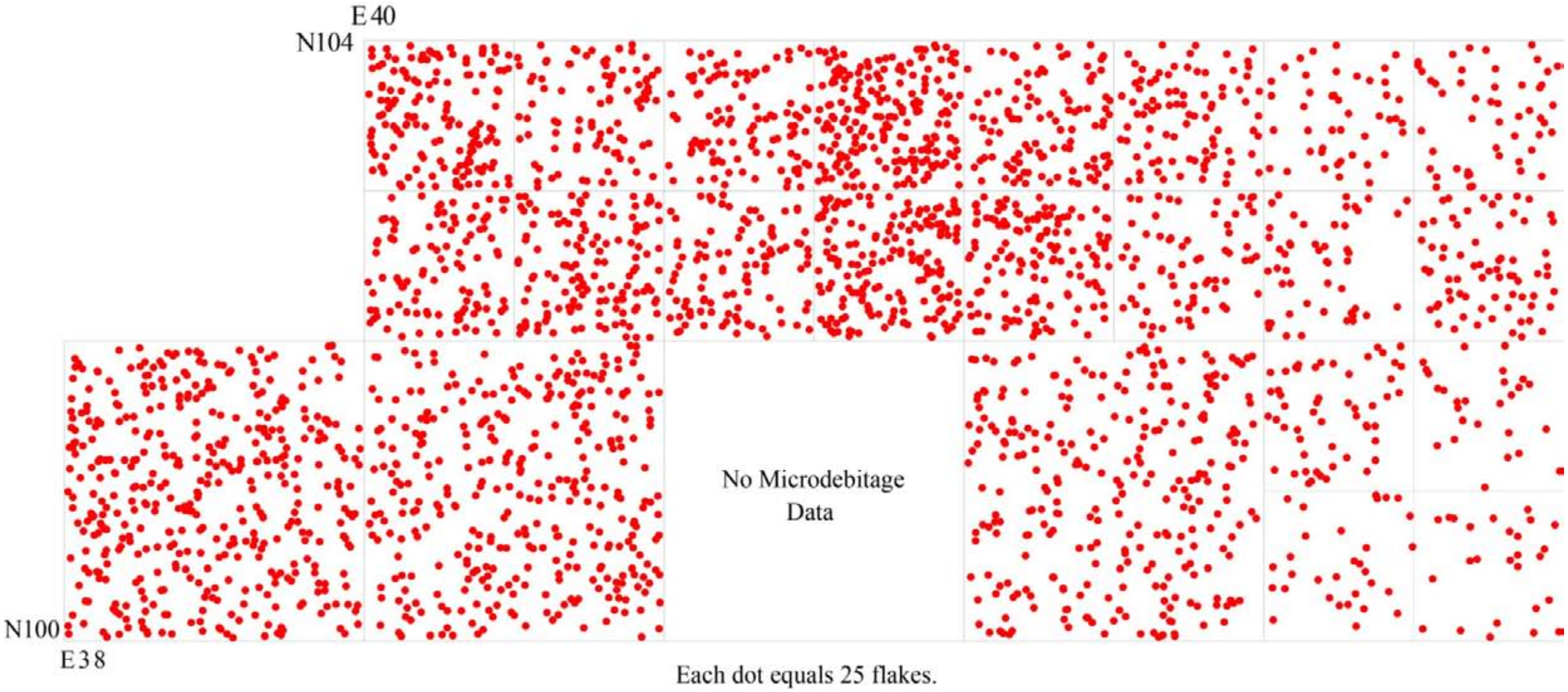


Figure 20. Random distribution of microdebitage to show density patterns across the block.

Next, piece-plotted artifacts were analyzed using k-means cluster analysis to identify spatial patterning. K-means is a non-hierarchial, divisive clustering technique to search for clusters that minimize the squared distance between a cluster's centroid and points in the cluster (SSE) (Kintigh and Ammerman 1982). The optimal cluster number was determined based on the plot of Within Sum of Squares (SSE) by the number of clusters (Figure 21). In Figure 21, the curve representing actual Topper data falls below curves representing maximum and minimum randomized point distributions, indicating the artifact data is not randomly distributed and forms meaningful clusters. Further, the point where the Topper data curve drops furthest from the randomized lines (i.e., the point where the actual data is least like the random data) represents the optimal cluster solution. For this analysis, a five-cluster solution appears to be optimal. Figure 22 shows the distribution of all piece-plotted artifacts and their corresponding cluster assignments.

To further confirm the cluster solution and understand the nature of individual clusters, I used a kernel density estimate to illustrate local density concentrations (Baxter and Beardah 1997). Kernel density estimations are similar to smoothed forms of histograms, and contours represent high and low frequencies in the data. Figure 23 shows 4 high density locations corresponding to cluster assignments 2, 3, 4, and 5 and one low density location correlated to Cluster 1.

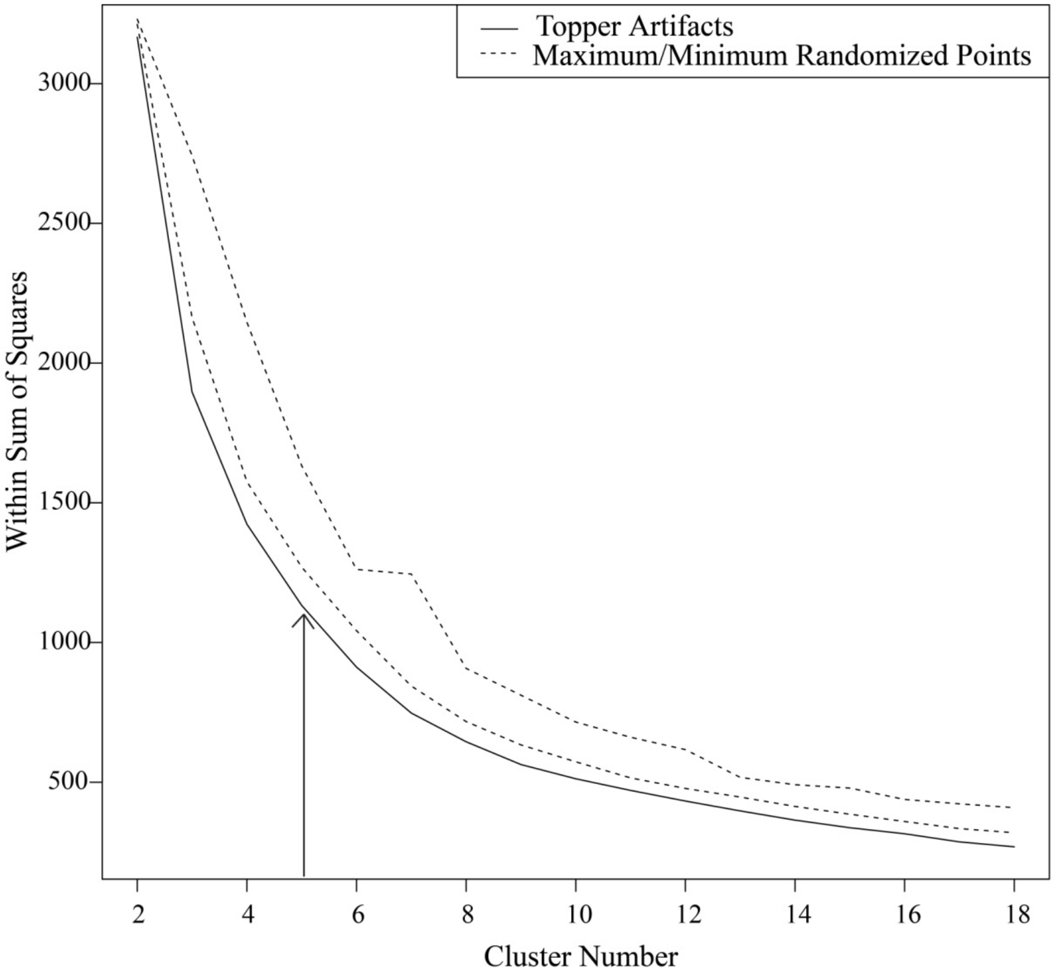


Figure 21. Plot of Within Sum of Squares (SSE) by the number of clusters to determine optimal cluster number.

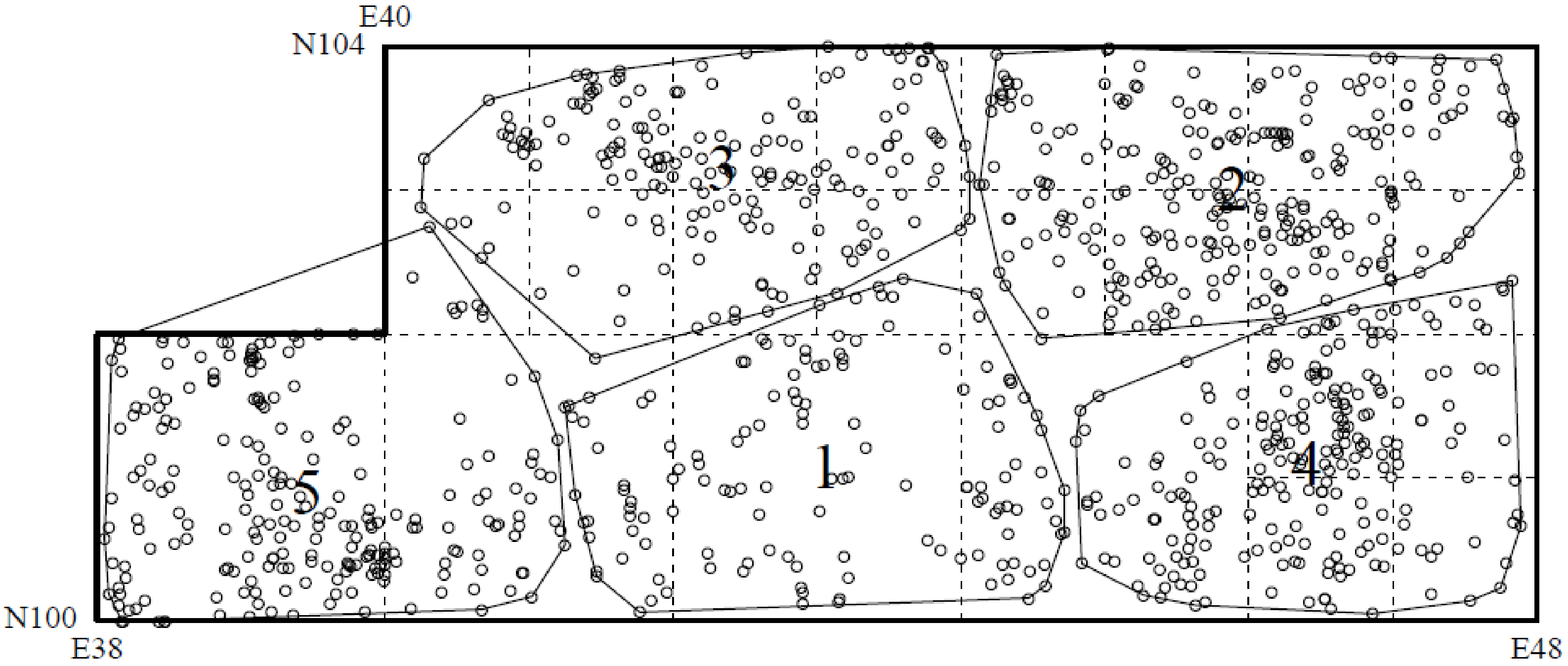


Figure 22. K-means analysis cluster assignments of all piece-plotted artifacts.

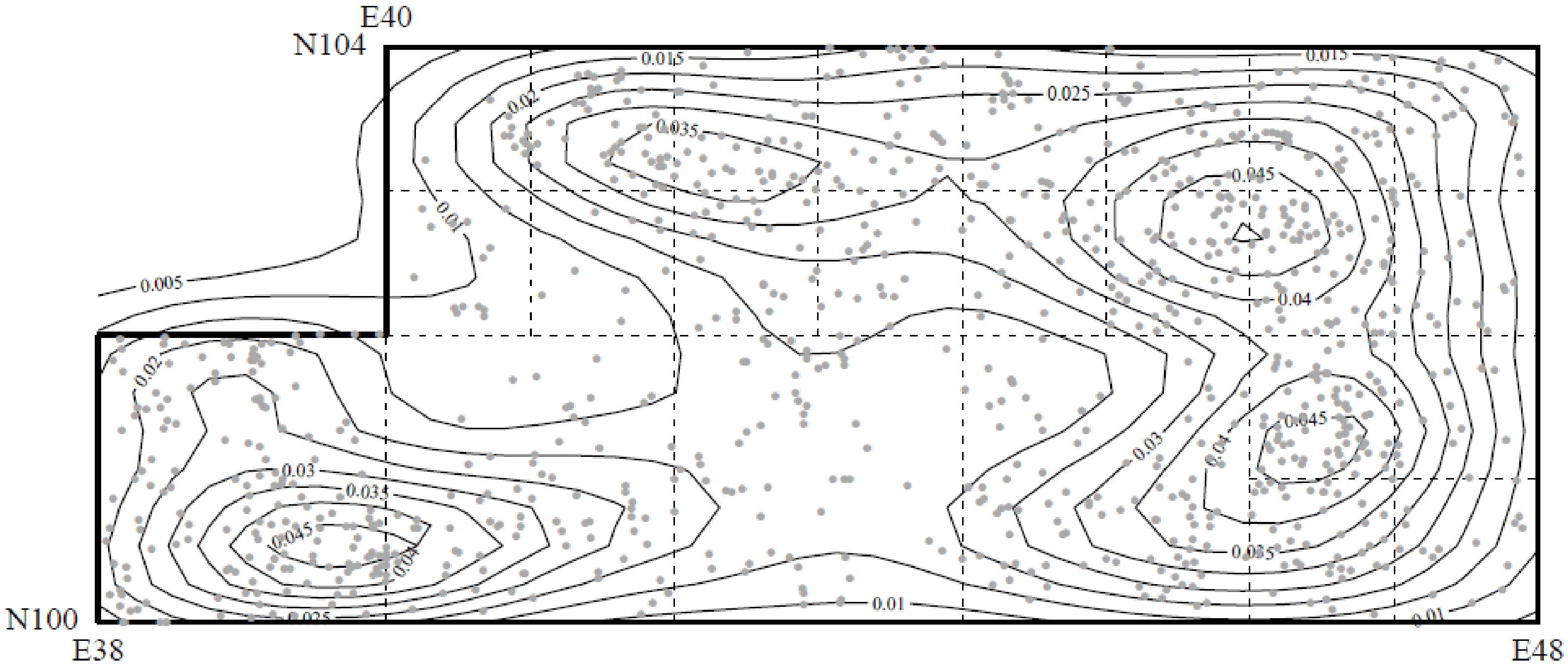


Figure 23. Kernel density plot of all piece-plotted artifacts.

Next, the 5 clusters were compared using chi-square analysis to determine if their contents vary in terms of debitage characteristics and frequencies of tool and core types. While all three dorsal cortex amount categories are represented throughout the block, the relative frequencies of dorsal cortex amount significantly vary from cluster to cluster ($p = 0.005$). Table 2 shows frequency spikes by cluster. Cluster 1 contains close to the expected amounts of flakes with complete, partial, and none dorsal cortex coverage. The other clusters have significant patterns of variation. Cluster 2 has more than expected completely-covered cortical flakes and less than expected non-cortical flakes. Cluster 3 contains more than expected flakes with partial cortex coverage. Cluster 4 is dominated by non-cortical flakes, with less than expected completely-covered cortical flakes. Cluster 5 is comprised of less than expected flakes with partial cortex coverage. These differences in relative frequencies of debitage dorsal cortex amount suggest that stages of reduction varied significantly across the Topper hillside.

Table 2. Dorsal Cortex Amount Frequencies by Cluster with Percent of Debitage within Cluster.

Cluster	Complete	Partial	None
1 (n = 106)	26 (24.5)	33 (31.1)	47 (44.3)
2 (n = 223)	78 (35.0)	69 (30.9)	76 (34.1)
3 (n = 144)	33 (22.9)	51 (35.4)	60 (41.7)
4 (n = 207)	45 (21.7)	55 (26.6)	107 (51.7)
5 (n = 193)	59 (30.6)	46 (23.8)	88 (45.6)
Total (n = 873)	241 (27.6)	254 (29.1)	378 (43.3)

$X^2 = 21.87$, df = 8, p = 0.005

Note: Total flake count excludes 9 undetermined flakes.

As noted, Clovis knappers predominately reduced nodules obtained from the hillside outcrop rather than the river bottom ($p = 0.023$); however, Cluster 1 has more than expected river chert and less than expected terrestrial chert (Table 3). While it is apparent Clovis knappers in this portion of the hillside favored the terrestrial source, the relatively greater use of river cobbles in Cluster 1 may reflect spatially distinguished variability in tool production goals.

Table 3. Chert Type Frequencies by Cluster with Percent of Debitage within Cluster.

Cluster	River Chert	Terrestrial Chert	Quartz
1 (n = 59)	13 (22.0)	46 (78.0)	0 (0)
2 (n = 146)	12 (8.2)	134 (91.8)	0 (0)
3 (n = 84)	6 (7.1)	77 (91.7)	1 (1.2)
4 (n = 99)	6 (6.1)	93 (93.9)	0 (0)
5 (n = 105)	10 (9.5)	95 (90.5)	0 (0)
Total (n = 493)	47 (9.5)	445 (90.3)	1 (0.2)

X^2 = 17.75, df = 8, p = 0.023
Note: Total flake count only includes flakes with cortex and quartz.
Three flakes were undetermined.

Evaluating the distribution of debitage classes by cluster reveals significant variation in the type of core reduction activities conducted across the hillside (p = 0.032) (Table 4). Because shatter cannot be assigned to a specific core reduction, it was removed from this analysis. Biface thinning flakes occur more than expected in Clusters 4 and 5 and less than expected in Cluster 3. Accordingly, Cluster 4 is also dominated by non-cortical flakes. These patterns further support the notion that production activities varied across the hillside, and based on debitage, in some portions of this area biface production was a primary production goal. The distribution of blades, blade-like flakes, and overshots do not significantly differ by clusters. Simple core reduction flakes make up the majority of the debitage assemblage, but the distribution is proportionally distributed by cluster.

Table 4. Debitage Class Frequencies by Cluster with Percent of Debitage within Cluster.

Cluster	Biface Thinning Flakes	Blade	Blade-like Flakes	Flakes	Overshots
1 (n = 105)	10 (9.5)	1 (1.0)	3 (2.9)	90 (85.7)	1 (1.0)
2 (n = 220)	12 (5.5)	4 (1.8)	9 (4.1)	195 (88.6)	0 (0)
3 (n = 136)	4 (2.9)	1 (0.7)	9 (6.6)	119 (87.5)	3 (2.2)
4 (n = 198)	23 (11.6)	1 (0.5)	2 (1.0)	170 (85.9)	2 (1.0)
5 (n = 187)	21 (11.2)	1 (0.5)	5 (2.7)	159 (85)	1 (0.5)
Total (n = 846)	70 (8.3)	8 (0.9)	28 (3.3)	733 (86.6)	7 (0.8)

$X^2 = 28.00$, df = 16, $p = 0.032$

Evaluating the distributions of debitage, tools, and cores helps to initially distinguish clusters formed during production activities versus those resulting from use activities. For this analysis, amorphous cores, blade cores, and bifaces were grouped as cores because these artifacts are objective pieces from which flakes are detached. The tool category includes secondarily modified flakes and cores (e.g., the chopper, scrapers, and denticulates). Finally, the debitage category is comprised of all flake debris, including overshots and blades. Based on the chi-square comparisons, there are significant differences in relative frequencies between clusters ($p = 0.001$). Cluster 1 has more than expected cores and tools, possibly representing both production and use activities. In contrast, Cluster 2 has more than expected debitage but less than expected tools and the lowest percentage of tools overall, indicating this cluster was primarily a production locus. Interestingly, Cluster 3 has more than expected cores but the lowest percentage of flaking debris, suggesting core reduction occurred in this loci but not to the same extent as elsewhere. Conversely, Cluster 4 has less than expected cores and the highest percentage of debitage, which could mean cores were thoroughly reduced in this cluster. Finally, Cluster 5 contains slightly more than expected tools, a pattern that suggests this cluster was a use-activity area.

To understand the spatial relationship of specific technological activities, tool and core types were evaluated by cluster (Table 5; Figure 24). For this analysis, overshots and blades, two debitage classes unique to Clovis, were grouped as diagnostic core reduction debitage and spatially analyzed with the tools and cores. Bifaces, biface fragments, the fluted point, and overshot flakes are categorized as evidence of biface reduction. Blades and blade cores are referred to as evidence of blade reduction. Retouched flakes, denticulates, the chopper, and the graver were grouped as modified flakes/cores. Side scrapers, end scrapers, and macroscraper/planes were grouped as a separate scraper category because these tool types represent a bulk of the flake tool assemblage. Relative frequencies of tools, cores, and diagnostic core reduction flakes are only nearly significantly different based on the clusters (*p* = 0.071), and the small sample size could be affecting the significance (Table 5). Cluster 1 contains more than expected scraper tools. In Cluster 2, there are more than expected blades and blade cores. Further, in this concentration, biface reduction is less frequent than expected. Cluster 3 includes more than expected amorphous cores and biface reduction. Cluster 4 has more than expected hammer stones, but the lowest percentage of amorphous cores. Cluster 5 is characterized by more than expected modified flakes and evidence of biface reduction.

Table 5. Tools, Cores, and Core Reduction Diagnostics by Cluster with Percent within Cluster.

Cluster	Amorphous Cores	Biface Reduction	Blade Reduction	Hammer Stones	Modified Flakes	Scraper Tools
1 (n = 27)	7 (25.9)	9 (33.3)	1 (3.7)	1 (3.7)	3 (11.1)	6 (22.2)
2 (n = 34)	11 (32.4)	7 (20.6)	6 (17.6)	3 (8.8)	3 (8.8)	4 (11.8)
3 (n = 39)	15 (38.5)	14 (35.9)	2 (5.1)	1 (2.3)	5 (12.8)	2 (5.1)
4 (n = 20)	2 (10.0)	4 (20.0)	2 (10.0)	5 (25.0)	5 (25.0)	2 (10.0)
5 (n = 37)	8 (21.6)	11 (29.7)	3 (8.1)	2 (5.4)	9 (24.3)	4 (10.8)
Total (n = 157)	43 (27.4)	45 (28.7)	14 (8.9)	12 (7.6)	25 (15.9)	18 (11.5)

$X^2 = 29.95$, df = 20, p = 0.071

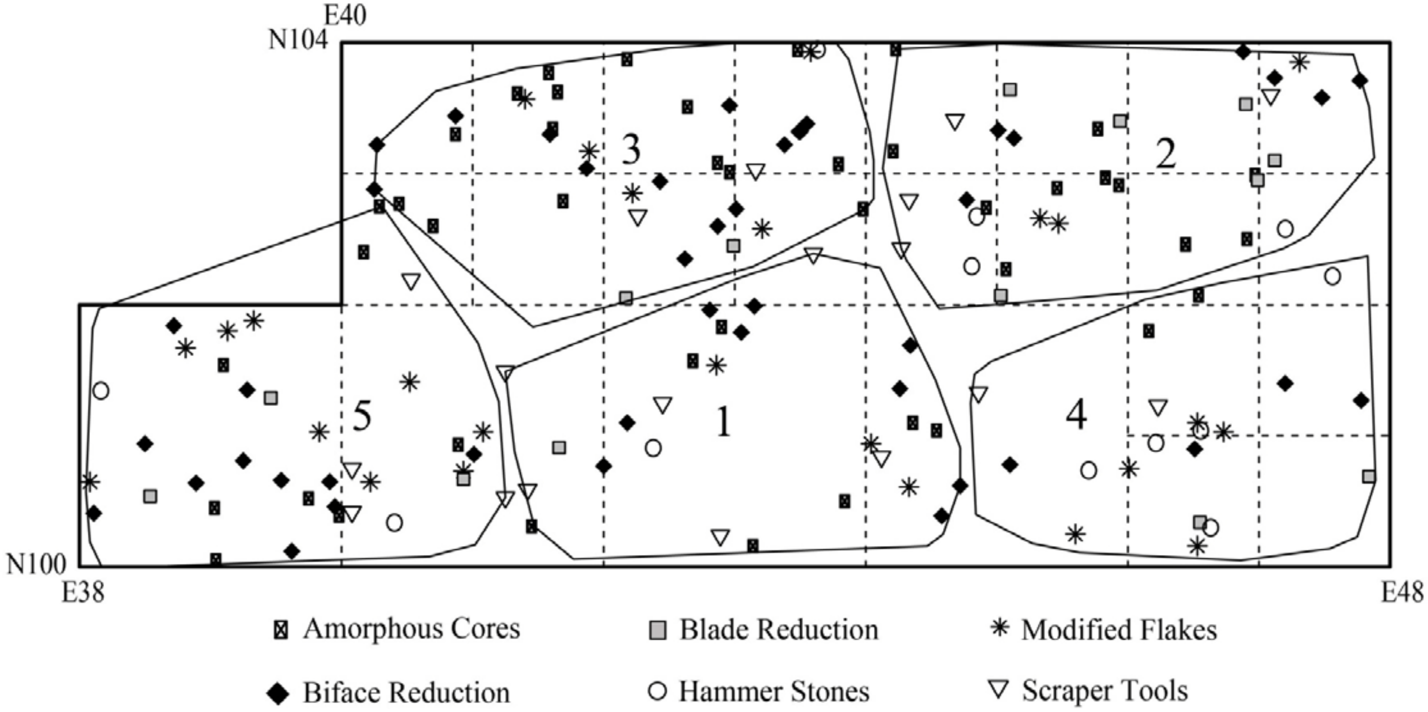


Figure 24. Horizontal distribution of tools, cores, and diagnostic reduction flakes.

As shown above, locational analysis of piece-plotted Clovis artifacts helps to distinguish patterns in the spatial organization of technological activities. Artifact distributions form meaningful clusters with densities that vary across the excavation block, suggesting there was spatial structuring. There are five distinct artifact clusters that appear to be activity loci. Based on dorsal cortex amount, chert outcrop type, and debitage class, these loci do not represent the same core reduction activities. In addition to variation in debitage characteristics, the clusters are significantly distinguished by relative frequencies of tools, cores, and debitage. These patterns can be further interpreted with the distributions of specific tools and core types. Cluster 1 is relatively less dense and characterized by secondary technological activities, with a unique increase in flakes with river chert and a predominance of scraper tools. Cluster 2 is a primary reduction activity locus; specifically, there are high frequencies of completely cortical flakes and low frequencies of non-cortical flakes and tools. In this cluster, blade production was a primary reduction goal. Cluster 3 is a production locus predominately comprised of partially cortical flake debris; however, despite a relatively high frequency of amorphous cores and bifaces, the relative frequency of flake debris is lowest in this cluster. Cluster 4 is a late stage reduction locus with a dense concentration of non-cortical debitage and an abundance of biface thinning flakes. In this cluster several hammer stones were left behind but cores, especially amorphous cores, are rare. Finally, Cluster 5 is characterized by secondary reduction activities; specifically, there are high frequencies of biface thinning flakes and bifaces, as well as more than expected modified flakes.

The evidence for spatially discrete activities with distinct production goals supports the previous assessment of the integrity of the Clovis assemblage. The buried Clovis component is characterized as a tight vertical concentration emplaced on the surface of a gentle slope, and artifacts associated with spatially structured activities are lying close to their original depositional context.

Discussion and Conclusions

The Topper hillside contains a buried Clovis component vertically separated from overlying Archaic and Woodlands components. Based on trend and plunge measurements, as well as diagnostic refits, the Clovis component was found in primary depositional context with minimal vertical dispersion. While the Clovis component has not been radiocarbon dated and cannot be visually distinguished as distinct soil horizons, the integrity of the Clovis component has been demonstrated through large block excavations, three-point proveniencing, conjoining artifacts, artifact plunges and trends, and spatial analysis of activity loci.

Flaking debris demonstrates that the entire reduction sequence is represented; Clovis knappers initially tested cortical nodules and continued to detach non-cortical flakes for tool production. The assemblage is characterized by biface and blade production with the technological signatures typical of Clovis; however, bifaces outnumber blades nearly 5 to 1. The predominance of amorphous cores indicates that informal core reduction was also an important strategy for producing flake and core tools. The variety of hammer stone sizes is consistent with a diversity in production goals. The array of tools, including side scrapers, end scrapers, and denticulates, with varied reduction indices, suggest tools were produced and used in this area of the hillside. Further, discrete artifact clusters have debitage, tools, and cores representing distinct technological activities, suggesting that aspects of tool production and use were spatially structured on the hillside. Cluster 1 is a use-activity locus where flakes detached from river nodules were chipped into scraper tools that were used through various reduction episodes. The high frequency of robust scrapers could be evidence of some type of woodworking (Miller and Goodyear 2009), and the co-occurrence of steeply keeled scrapers with the highest frequency of flake debris with remnant river cortex may be evidence of the differential preference for rounded river cobbles for unifacial tool production. Cluster 2 was an area where intense early-stage core reduction took place, and rather than biface production, Clovis knappers focused on the production of blades. In Cluster 3, bifaces and amorphous cores were initially shaped and thinned secondarily, but the extent of this production process produced relatively little flake debris. Cluster 4 was a late-stage reduction locus where bifaces were modified in the final shaping process, but only the flake debris remains in significant quantities. The majority of these bifaces were transported away from the cluster, but knapping hammer stones were left behind. Cluster 5 was also a late-stage biface knapping locus, but in this cluster, relatively more bifaces and biface fragments were left behind. Included in this locus are two conjoined biface fragments and the expended, broken Clovis point base.

Also, the high frequency of modified flakes indicates tool-use activities, perhaps related to haft maintenance, also took place in this cluster.

The spatial patterning, with discrete knapping loci showing distinct production goals, suggests that the hillside Clovis occupation does not represent the accumulation of numerous indistinguishable quarry visits, but rather a combination of both production and use activities conducted on a workshop floor.

The Clovis Archaeological Record at Topper

The hillside block only represents 7% of the total excavated site area at Topper, and to date, the horizontal extent of the Clovis component remains unknown. Thus, the occupation history at Topper is likely much more complex and presumably involves repeated occupations. Nonetheless, the analysis presented here of the 40-m^2 hillside block helps contribute to a more thorough understanding of the nature of the Clovis occupation at Topper.

Core and tool types in the hillside assemblage have been noted in other areas of the Topper site. In a previous analysis of a 64-m^2 excavation block (referred to as the firebreak excavation block), situated approximately 3 m south of the hillside block, Miller (2010) identified a vertically discrete zone of Clovis artifacts with minimal downward vertical displacement of post-Clovis artifacts (Figure 2). The hillside and firebreak Clovis assemblages are similar because they both contain amorphous cores, blade cores, bifaces, blades, side scrapers, end scrapers, macroscrapers, and denticulates

(Miller 2010; Smallwood et al. 2011). The firebreak assemblage, like the hillside, was characterized by a higher frequency of amorphous cores, indicating the importance of flake core reduction, as opposed to blade core reduction, for the production of tools at Topper (Miller 2010; Smallwood et al. 2011). Further, the presence of denticulates and macroscrapers in both assemblages demonstrates that these are regularly occurring tool types at Topper. The rarity of these tools at other Clovis sites may reflect special use-activities unique to the biogeographic setting of Topper during the Pleistocene (Miller and Goodyear 2009).

All areas of Topper were not used for the same types of activities or with the same intensity (Smallwood et al. 2011). Interestingly, the hillside block has a higher density of artifacts per m^2 than the firebreak; the hillside assemblage has nearly twice the number of cores, bifaces, blades, and flake tools per m^2. If the hillside represents a single workshop floor, this difference in density suggests a relatively greater intensity of use. Additionally, preliminary results indicate that the density of artifacts continues to increase further up the escarpment in excavations blocks approximately 50 m north. This pattern confirms that the hillside was not simply a task-specific location for the procurement and testing of chert nodules but rather served as a workshop floor—one of many floors at Topper—for multiple technological activities. Further, the hillside block assemblage is dominated by debris, cores, and tools crafted from the Coastal Plain chert found on-site, and this pattern is also true for the surrounding 550 m^2 of the excavated Clovis component. A total of only 6 tools made on non-local raw materials have been recovered at Topper (Goodyear et al. 2009). The evidence for multiple site activities and the predominance of local raw material suggests that Clovis occupants used the Topper site for more than just a procurement-specific location. Topper likely served as a residential base.

Clovis Procurement-Related Sites in the Southeast

The bifacial, blade, and informal core technologies identified in the Topper hillside assemblage are characteristic of Clovis technology in the Southeast (Smallwood 2010). Similar assemblages are reported at other procurement-related sites in the region, including Carson-Conn-Short, Adams, and Williamson (Broster and Norton 1993; Gramly and Yahnig 1991; Peck 2004; Sanders 1990) (Figure 1). While the detailed technological analyses reported for these assemblages are important for our understanding of the key characteristics of Clovis technology in the Southeast, within-site spatial analyses were not reported. Within the 40 m^2 analyzed here, a workshop floor with discrete knapping loci created with unique production and use goals was identified. This analysis demonstrates that Topper is more than an indistinguishable, homogenous occupation; instead, there is spatial patterning that shows Clovis people organized and structured on-site activities at procurement-related sites. Perhaps by recognizing the archaeological residues of these structured activities we can begin to compare behavioral patterns in site-use on a regional scale.

CHAPTER III

CLOVIS BIFACE TECHNOLOGY AT THE TOPPER SITE, SOUTH CAROLINA: EVIDENCE FOR VARIATION AND TECHNOLOGICAL FLEXIBILITY*

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.

---

*Reprinted with permission from “Clovis Biface Technology at the Topper Site, South Carolina: Evidence for Variation and Technological Flexibility” by Ashley M. Smallwood, 2010. *Journal of Archaeological Science*, 37, 2413-2425, Copyright 2010 by Elsevier Ltd.

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 (Figure 25). 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, 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.

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). 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).

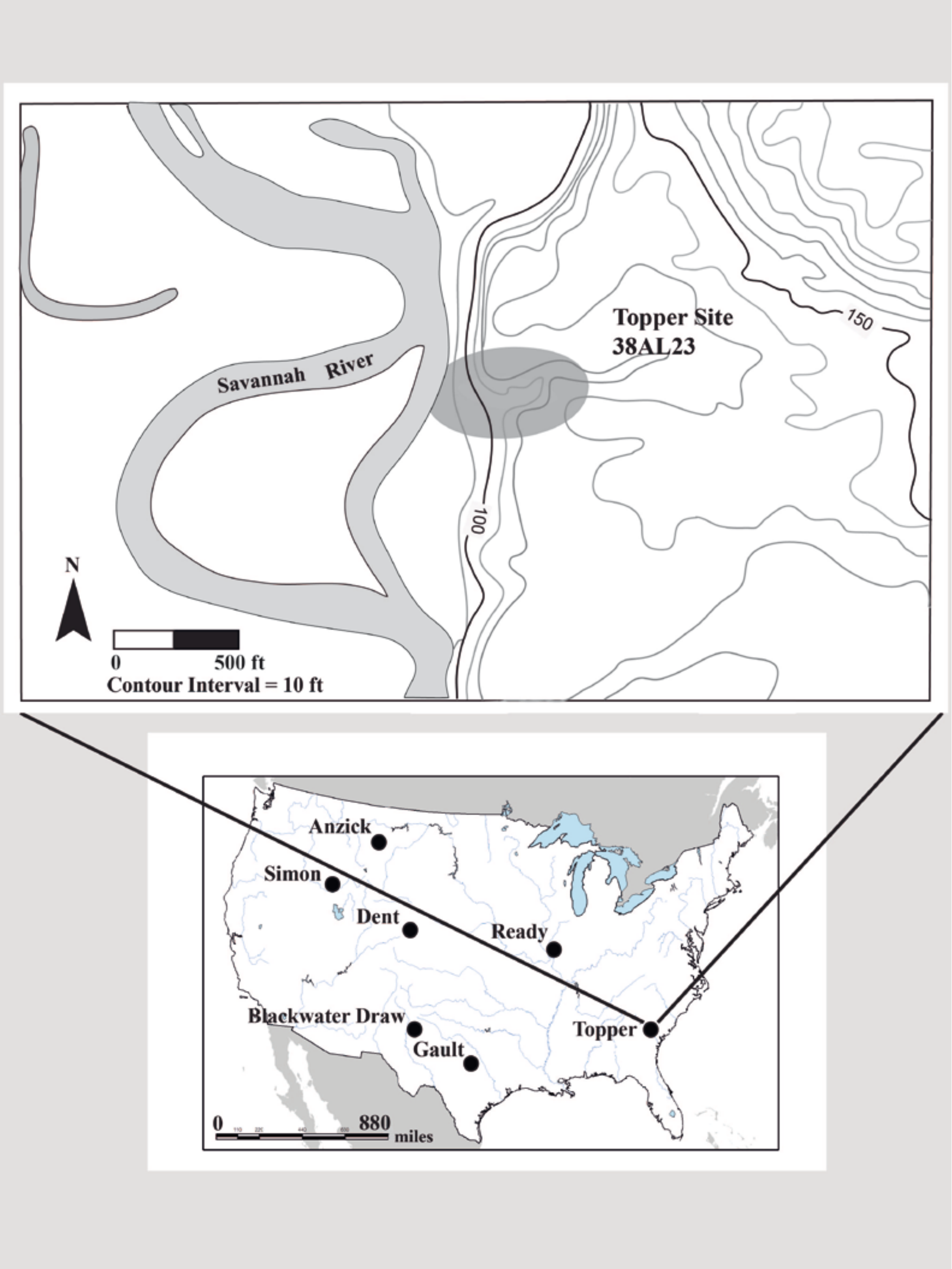


Figure 25. Map of the Topper site along the Savannah River, South Carolina with United States map showing locations of Clovis sites mentioned in text. Contour elevations taken from U.S.G.S.Quad 33N/81W.

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. 2011). With their analysis of the assemblage at Gault, a quarry-campsite in central Texas, Collins and Hemmings (2005) describe 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 preform. 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.

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.

Materials

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 2005b). Excavations have continued, and as of 2009 the Clovis component covered a total excavated area of 590 m².

Topper is one of only two excavated Clovis sites in the South Atlantic Coastal Plain (Goodyear 2005b). 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

(Figure 26). 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),

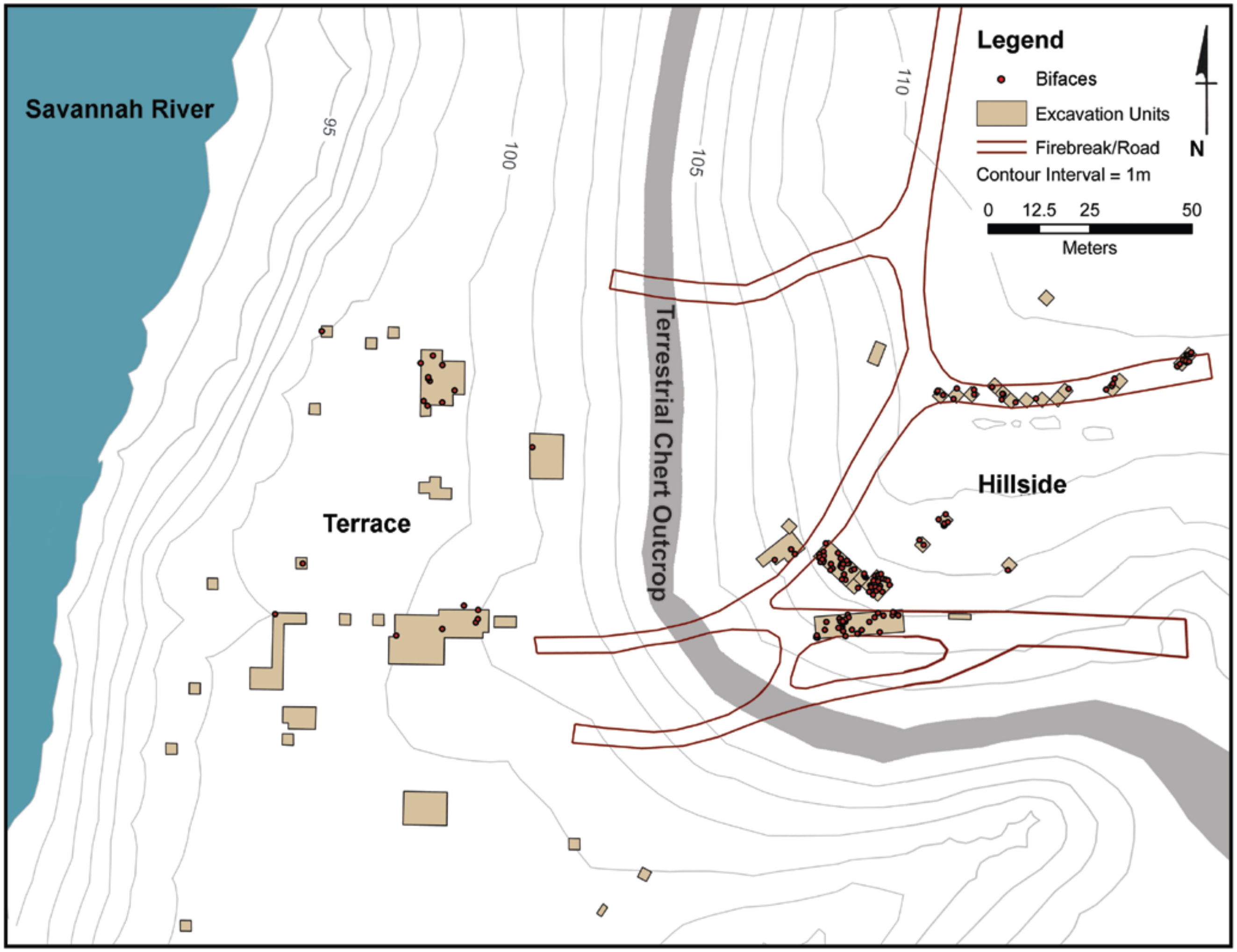


Figure 26. Map of Topper site excavation blocks, showing excavated bifaces as red dots. Elevations based on site datum arbitrarily set at 100 m (Smallwood and Miller 2009).

there have been four separate block excavations. A spatial analysis of the largest contiguous block, an area of 64 m², 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 m²) 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.

The Clovis Biface Assemblage

A total of 174 bifaces and biface fragments has been recovered from the buried Clovis components on the terrace (n = 20) and hillside (n = 154) (Figure 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 m² of excavation (Figure 27). 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) (Figure 27b) 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).

Methods

Variables Recorded

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

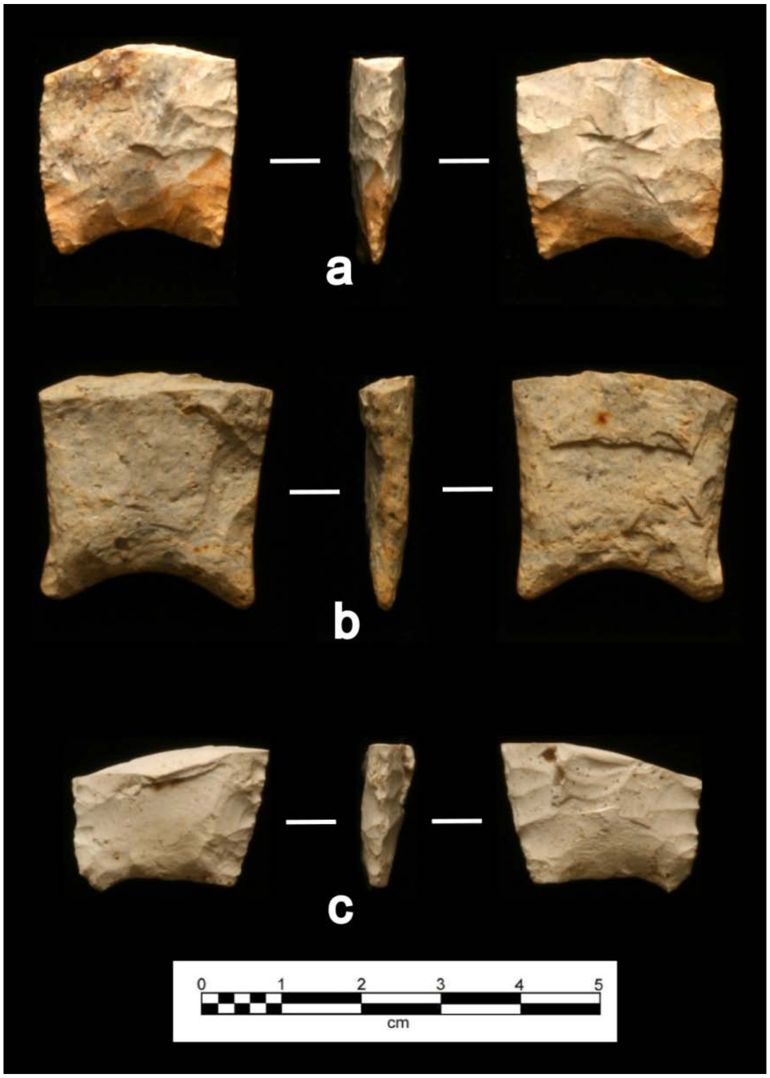


Figure 27. Clovis point fragments found in the buried Clovis component.

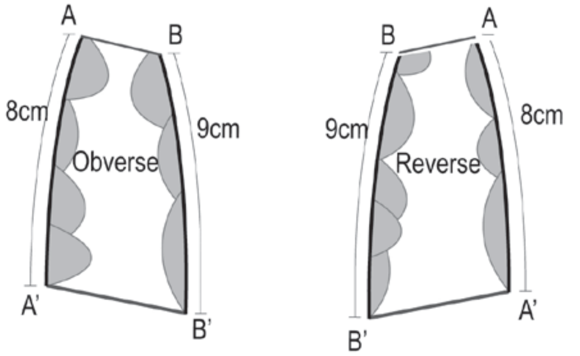
Technological variables measured included condition, original blank form, presence of cortex, planview, edge shape, presence of edge grinding, base shape, transverse cross-section, and platform preparation on thinning flakes (Table 6). These variables helped to document the nature and extent of reduction, 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; Collins et al, 2007; Waters et al. 2011). These diagnostic Clovis removals helped to document thinning strategies.

Table 6. 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

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 2011). 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 (Figure 28). 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 2011.). 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 (Figure 29). 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 sinuousity, and flake-removal technique (Waters et al. 2011). Statistically, the three stages of reduction approximate values obtained through the flaking index (Figure 30). 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.



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

A - A’	B - B’
Flake Scars (S)	Flake Scars (S)
Obverse = 4	Obverse = 3
Reverse = 3	Reverse = 5
Total (S_A) = 7	Total (S_B) = 8
Length (L_A) = 8cm	Length (L_B) = 9cm

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

Figure 28. Graphic illustrating the calculation of flaking index (Miller and Smallwood 2011).

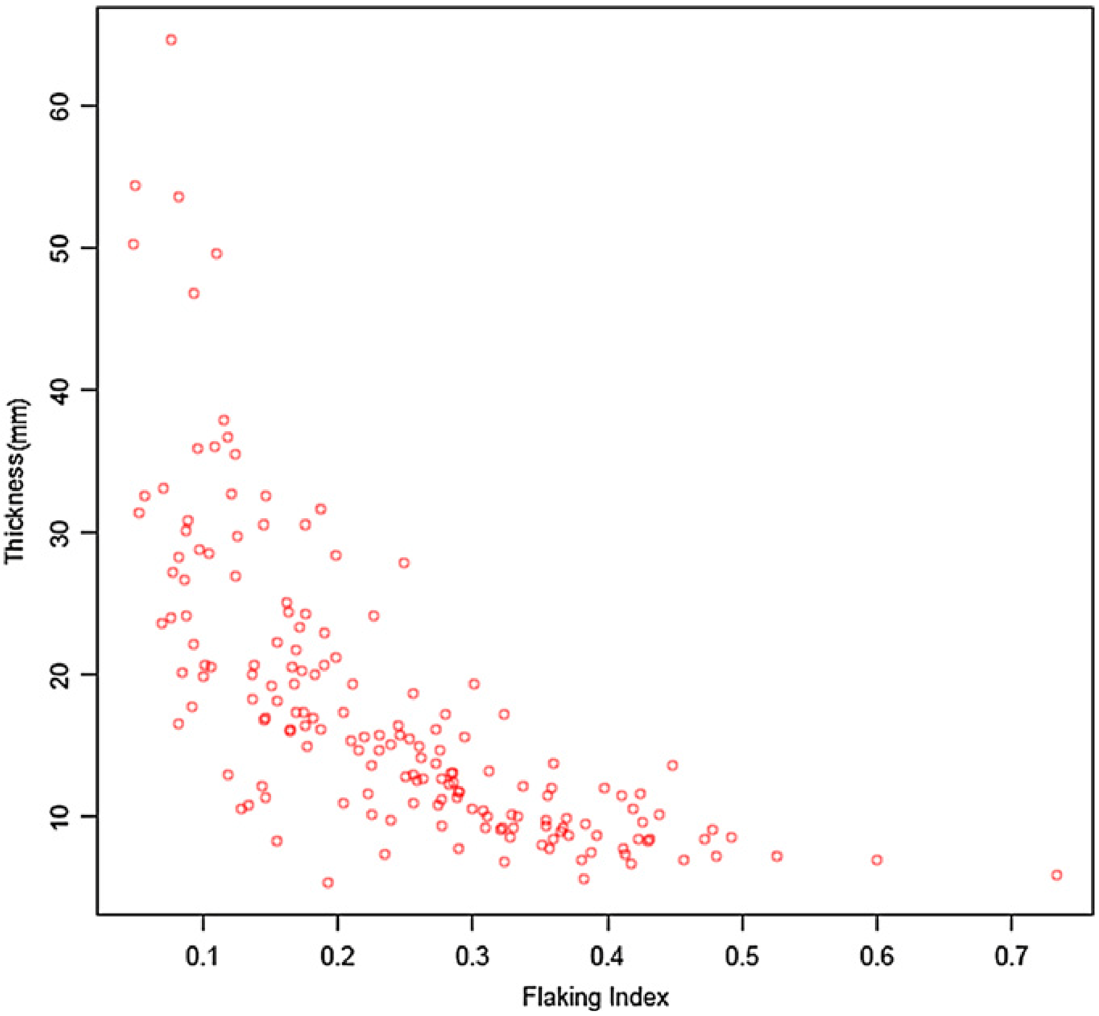


Figure 29. Bifaces plotted by flaking index and thickness. Graph shows an inverse relationship demonstrating that these variables estimate stage of reduction at Topper.

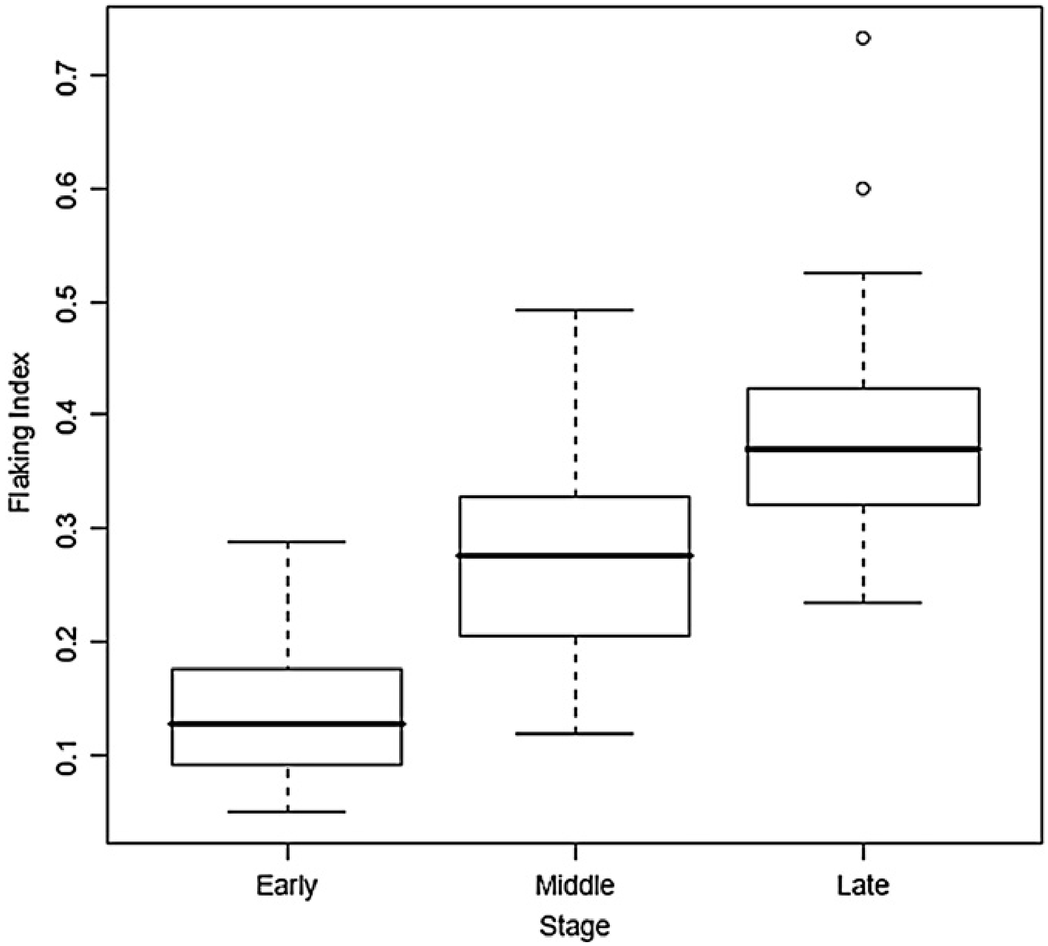


Figure 30. Bifaces distributed by flaking index and stage. Black line represents the median flaking index. Boxes are bounded by the 1st and 3rd quartiles. Circles are individual outliers—two finished discarded fluted points.

Results

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, personal communication 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%).

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 (Figure 31). A total of 280 overface-flake and 46 overshot-flake scars were recorded on the 174 Topper bifaces,

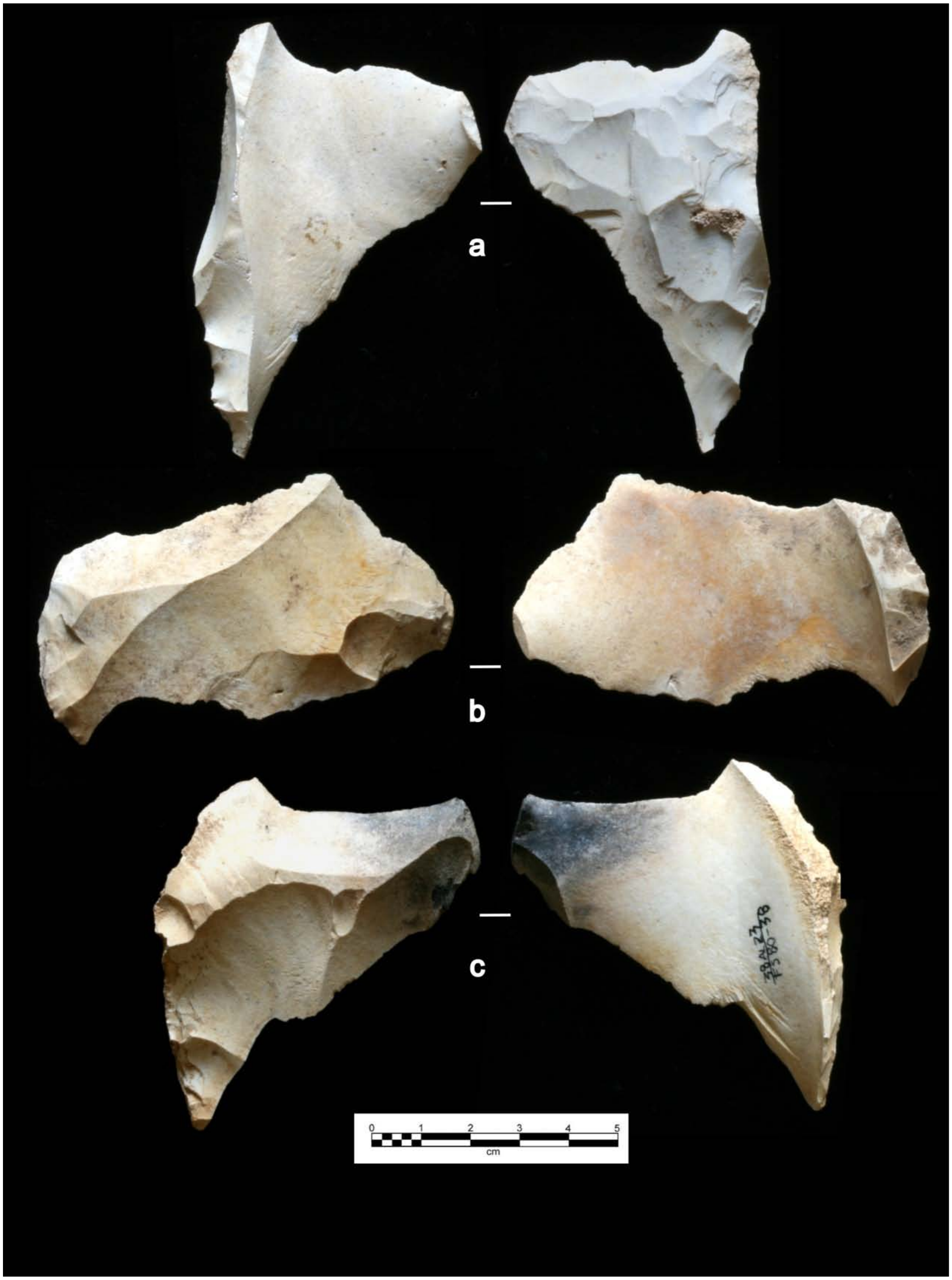


Figure 31. Overshot flakes from the excavated Topper assemblage.

an average of 1.61 overface-flake and 0.26 overshot-flake removals per biface (Table 7). 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 8, 9). 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 10). Final end thinning or fluting also is present on all three point bases. Thus, this thinning strategy was used throughout the reduction process.

Table 7. 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 (0.62)	46 (0.68)	45 (1.18)	133 (0.76)
Total	149	174	136	459

Table 8. 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, $p = 0.3987$

Table 9. 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, $p = 0.05731$

Table 10. 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 (54.41%)	18 (26.47%)	11 (16.18%)	2 (2.94%)	0 (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, $p = 0.1384$

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 (Figure 32). 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 (Figure 33). 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.

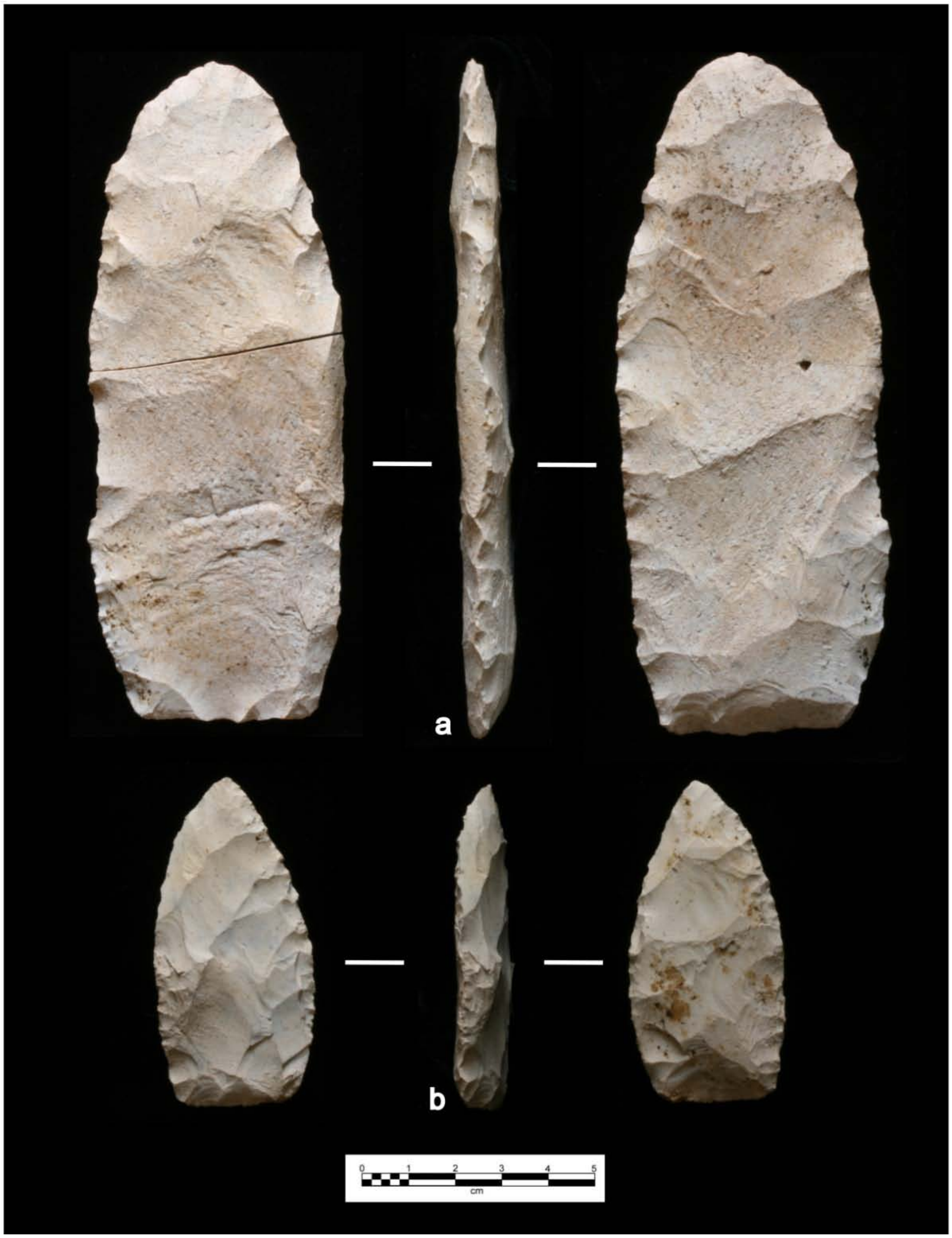


Figure 32. Examples of preform size variation at Topper: (a) preform with length (144.83 mm) similar to standard descriptions of Clovis preforms and (b) preform with length (69.7 mm) similar to used, finished Clovis points.

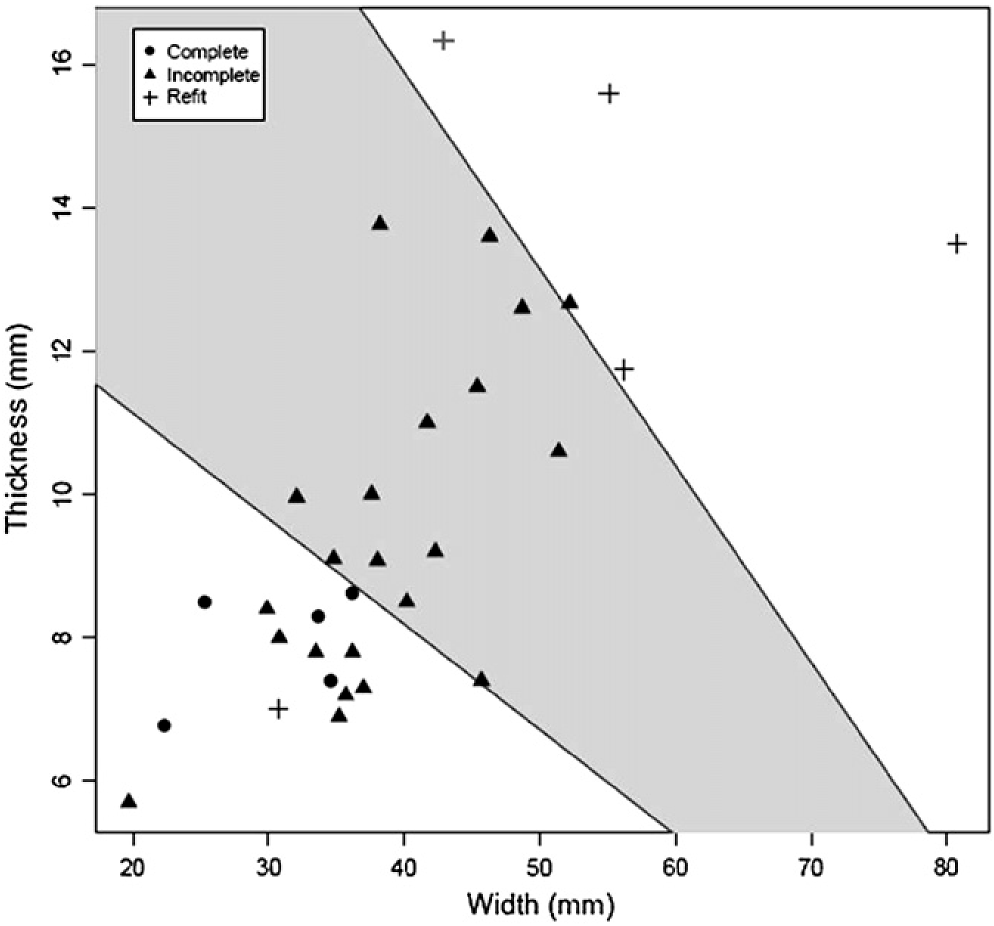


Figure 33. All preforms evaluated by width and thickness. The highlighted portion represents preform fragments that fall within the middle size range, with no complete discarded preforms of this size found at the Topper quarry. Preforms from other Clovis sites generally fall within this middle size range.

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 (Figure 34). Large preforms have lengths and widths that range from 115.0 to 144.80 mm and 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.

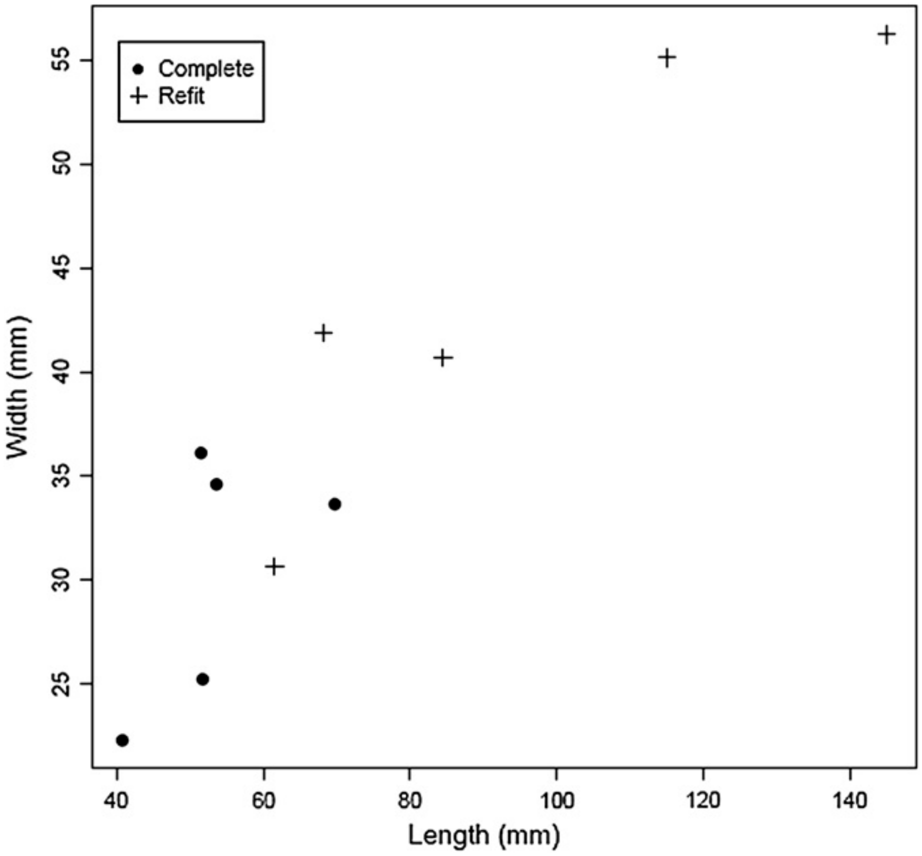


Figure 34. Complete preforms evaluated by length and width. Preforms cluster by size groups, demonstrating that Topper flintknappers were crafting preforms that varied in size.

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 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 to 42 mm wide by 9 to 12 mm thick (Figure 33). 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.

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 (Figure 35). Five are small expended flake cores ovoid in shape with maximum linear 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 (Figure 36). 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 have 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 (cf., 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 (cf., 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 (cf., Bamforth 2007; Keely 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.

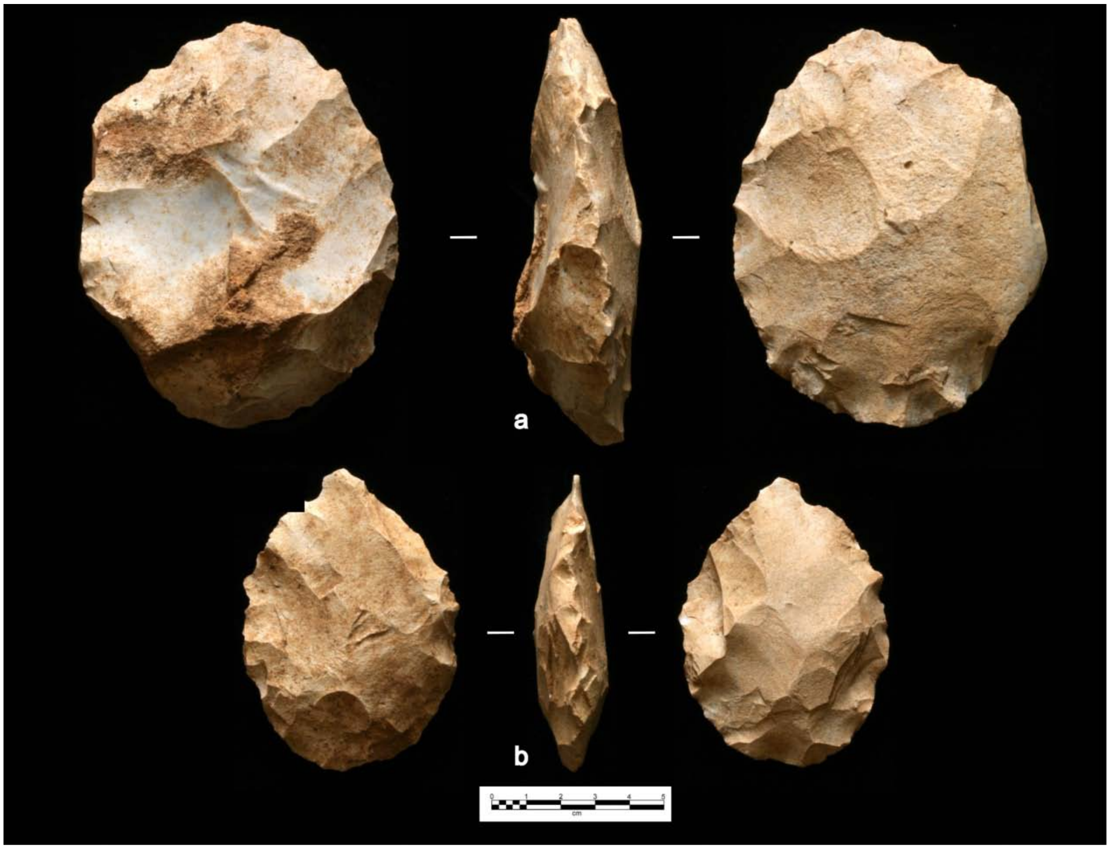


Figure 35. Examples of cores from the Topper excavations: (a) discoidal core and (b) small flake core.

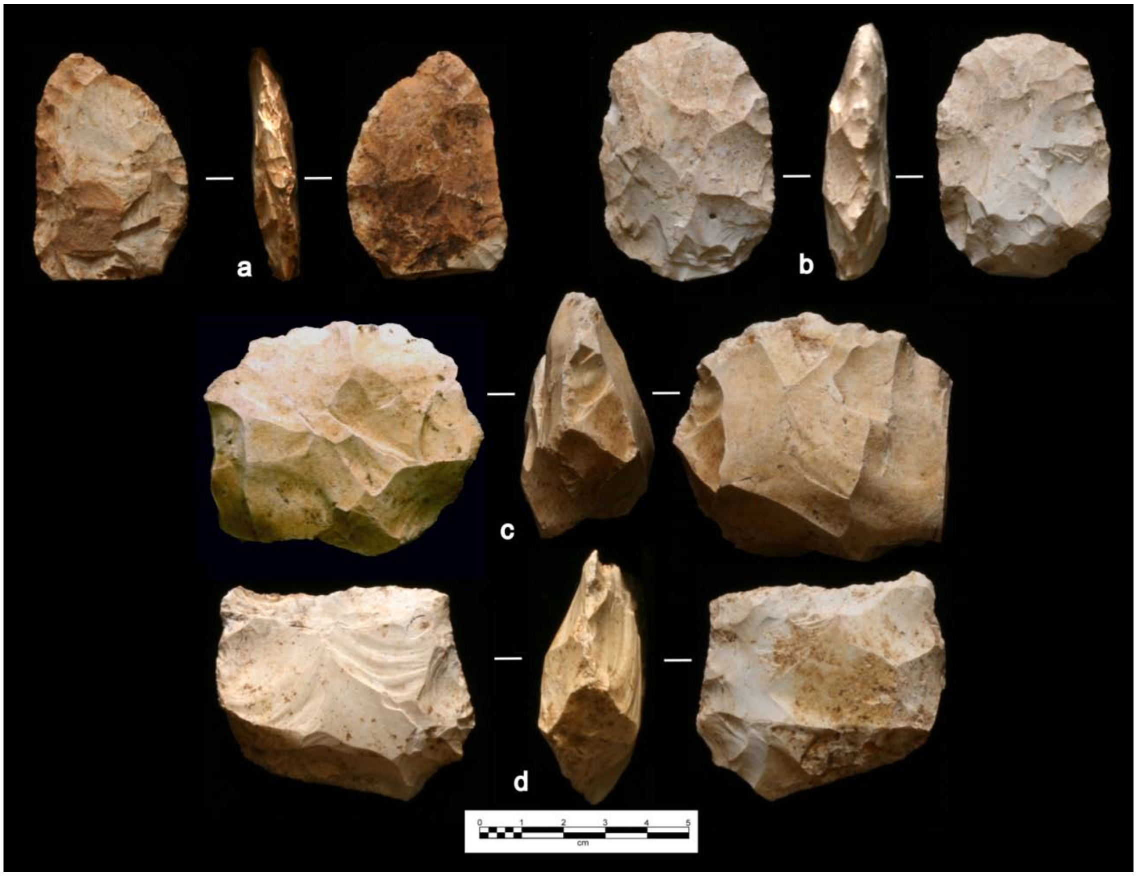


Figure 36. Examples of bifacial tools: (a) knife, (b) adze, (c) chopper, and (d) wedge.

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 macroblades, 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.

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. 2011). 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. 2011). 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 11). Topper Clovis point fragments, however, do not have remnants of overface or overshot thinning. These flake scars were obliterated by subsequent flaking.

Table 11. 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%)

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 10, 11). This variability in thinning strategies may be a product of original blank form. Many Topper bifaces were crafted on spalls, while the majority of Gault bifaces (≈ 77%) were made by fully reducing tabular chert nodules (Waters et al. 2011). 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.

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 sites, preforms are consistently more than 100 mm long and 40 mm wide (Bradley 1993; Collins 2007; Huckell 2007; Waters et al. 2011). 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 and ≈ 20 and 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. 2011). 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 Pleistocence/Holocene transition when the extinction of megafauna may have led to Paleoindian hunters targeting smaller animals, thus the technololgical 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, personal communication 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 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. 2011:70). 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) (Figure 37). 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) ($p < .01$). 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.

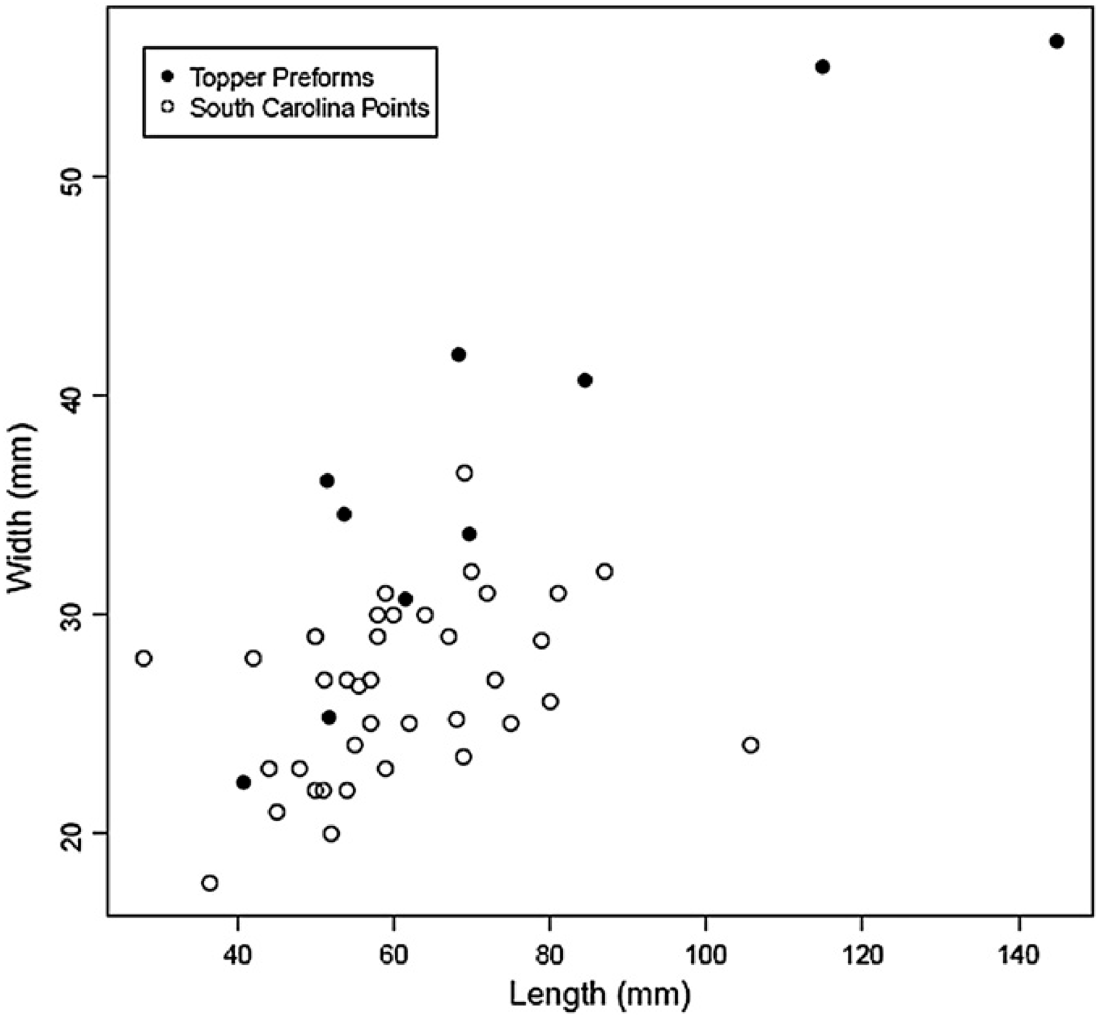


Figure 37. Comparison of complete South Carolina isolated points and complete/refitted small Topper preforms plotted by length and width. In terms of length, small Topper preforms could be taken away from the quarry and crafted into points.

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).

What Does the Topper Biface Assemblage Tell 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.

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.

CHAPTER IV

CLOVIS TECHNOLOGY AND SETTLEMENT IN THE AMERICAN SOUTHEAST: USING BIFACE ANALYSIS TO EVALUATE DISPERSAL MODELS

The widespread evidence of Clovis people throughout North America has led many researchers to model early Paleoindian settlement systems and the effects these systems had on technology. Kelly and Todd’s (1988) “high-technology forager” model predicts Clovis groups were highly-mobile populations that left behind behaviorally-consistent records of Clovis fluted points as evidence of their short-term occupations. Anderson’s (1990,1996) staging-area model predicts that Clovis settlement was more gradual; groups entered the continent and slowed migration to concentrate territorial ranges around resource-rich river valleys, and these staging-areas became the demographic foundations for early cultural regionalization. This study analyzes southeastern Clovis point data and biface assemblages from Carson-Conn-Short, Topper, and Williamson to test the technological implications of these two models. Significant subregional variation exists in Clovis point morphology and biface production techniques. This variation suggests the subregions represent distinct populations who distinctly altered aspects of their technology but maintained fundamental elements of the Clovis tradition. These findings are at odds with the high-technology forager model and more closely fit the staging-area model.

Traditional models predict early Paleoindians were highly-mobile big-game hunters who continually shifted ranges and were “technology-oriented” (Beaton 1991; Kelly 1996; Kelly and Todd 1988:239); however, with newly excavated sites, many of which are not kill sites, archaeologists have begun to realize that considerable variability existed in Clovis technology, subsistence, and settlement. Nowhere in North America has this change in perception been more evident than in the American Southeast (Anderson 1991, 1996, 2005; Broster and Norton 1992, 1993; Broster et al. 1994; Meltzer 1988). Based on relative fluted-point concentrations across the country, Anderson has suggested that Clovis groups in this region were more place-oriented and less mobile than predicted by the high-technology/high-mobility models. This paper uses site-level data to test the traditional high-technology/high-mobility models against Anderson’s (1990, 1995, 1996) “staging-area model,” which predicts a gradual, step-wise mode of Clovis dispersal and settlement of North America.

To investigate the suitability of the staging-area model, I analyze bifacial technological organization represented at three sites located in different areas of the Southeast (Figure 1): Carson-Conn-Short (Tennessee), Topper (South Carolina), and Williamson (Virginia). Carson-Conn-Short is in an area Anderson predicted to be a primary staging area, where colonizing populations of Paleoindians first concentrated and settled (Anderson 1990:188), while Topper and Williamson are in areas Anderson predicted to be later population concentrations, areas discovered by groups secondarily dispersing from the initial staging area. Besides collections from these sites, I also analyze known fluted points from surrounding counties, investigating regional variation in fluted point morphology. The Paleoindian Database of the Americas (PIDBA) is used as a reference for raw material type and metric attributes of the isolated fluted points (Anderson et al. 2010).

My analysis of the *chaînes opératoires*, or lithic reduction sequences, represented in the assemblages of the Tennessee River valley, Savannah River valley, and Virginia Piedmont indicate significant inter-regional variation in Clovis bifacial technology and finished point morphology, and this suggests incipient cultural regionalization in the American Southeast as early as Clovis times. These patterns are not consistent with the high-technology/high-mobility model, but do fit Anderson's staging-area model.

Modeling Clovis Settlement

Clovis technology is generally recognized for its characteristic bifacial fluted projectile point (Bradley et al. 2010; Collins et al. 2007; Morrow 1995), a tool first defined at Clovis sites in the Plains and Southwest (Stanford 1991; Tankersley 2004; Willig 1991; Wormington 1957). One of the most remarkable aspects of Clovis is its extensive geographic distribution covering all of North America south of the Continental ice sheets (Haynes 2002; Tankersley 2004; Willig 1991). Most archaeologists explain the ubiquity of Clovis through human migration (Anderson 1991, 1996; Fiedel 2004; Goebel et al. 2008; Haynes 2002; Kelly 1996; Kelly and Todd 1988; Meltzer 2002, 2004) (but see Willig 1991; Waters and Stafford 2007), and in Paleoindian studies, the lithic record is key to understanding human migrations and cultural change. Lithic analysts study cultural transmission through the reconstruction of the *chaîn opératoire* and morphological analyses of tools forms (Bordes 1967; Bradley and Stanford 2004; Lothrop 1989). While variability within Clovis points can be caused by idiosyncratic behavior or differences in raw material, tool use and rejuvenation (Bradley 1991; Dibble and Rolland 1992; Frison 1978; Haynes 1982; Otte 2003; Sackett 1985), there are still distinct aspects of technological variation that may be culturally based (Daniel and Wisenbaker 1989; Flenniken 1985; Larson 1994; Sellet 1993; Stanford 1991; Tankersley 2004; Wiessner 1983; Willey 1953; Willig 1991). I follow Mace (2005), O'Brien et al. (2001), and Richerson and Boyd (2005), who have argued that such similarities represent shared cultural heritage. Further, like Bettinger and Eerkins (1999), Faught (2006), Hofman (1987), Meltzer (1988), Morrow and Morrow (1999), O'Brien et al. (2001), Odell (1989), and Willig (1991, 1996), I argue that through either temporal and/or spatial separation, cultural transmission within isolated groups was likely a primary source of regional assemblage variation.

Because of the widespread evidence of Clovis people, many scholars have attempted to model their settlement systems and the effects these systems had on their technology. Two competing models of Clovis settlement are the "high-technology forager" (HTF) model (Kelly 1996; Kelly and Todd 1988) and the "staging-area" (SA) model (Anderson 1991, 1996). Below, I briefly review the major tenets of these two models, especially as they relate to Clovis bifacial technology

High-Technology Forager Model

According to Kelly and Todd (1988), Clovis people migrated into an unpopulated country through the ice-free corridor in western Canada, preadapted with the necessary skills and tools to hunt large Pleistocene mammals. Under pressures of a rapidly changing environment, the predisposition for hunting allowed small groups to quickly move across the landscape following familiar resources and avoiding setbacks caused by diminished local food sources and patchiness (Kelly 1996). Clovis people did not adapt locally to a wide-range of environments; rather, these “high-technology foragers” relied on elaborate bifacial tools and knowledge of ungulate behavior to rapidly move from one environment to the next (Kelly 1996:231; Kelly and Todd 1988). Clovis migration across North America was quick, through diverse environmental zones, leaving a behaviorally consistent record of Clovis-style fluted points and site types—kill sites, caches, and short-term campsites (Kelly and Todd 1988).

According to the HTF model, the Clovis lifeway was “technology-oriented” rather than “place-oriented” (Kelly 1996; Kelly and Todd 1988:239). Early Paleoindians were not concerned with specific environments around them, nor did they habitually factor terrestrial resources into their subsistence. By abandoning dependency on local environments, instead exploiting large herbivores, Clovis people shifted ranges frequently but maintained consistent behavioral adaptations and land-use patterns. They rarely if ever settled into a particular area for long and carried a tool kit that allowed them to move far from known raw-material sources. Highly mobile Paleoindians relied on a portable technology of long-lasting and multi-purpose tools fashioned from high-quality cryptocrystalline raw materials (Goodyear1989; Kelly and Todd 1988).

The HTF model was the first to emphasize the role of bifacial tools in Paleoindian mobility patterns, and since then this interpretation has been generally accepted as a standard for understanding Clovis technology (but see Bamforth 2003; Prasciunas 2007). According to this model, the Paleoindian tool kit consisted primarily of bifaces with sharp but durable edges and width-to-thickness ratios that allowed for the removal of large flakes for expedient use (Kelly 1988). Bifaces served as cores that functioned “like Swiss Army knives”—many tools could be produced from a single bifacial core, besides finished points. Further, the weight-to-edge ratio ensured that mobile groups were less burdened by large amounts of stone but still able to produce needed tools (Kelly 1988:719). Kelly and Todd (1988:236) concluded that high mobility and curatable tools were responsible for what they consider to be a lack of regional variation in fluted-point styles.

Staging Area Model

The discovery of extensive Clovis sites in the Southeast (Anderson 1991, 1996; Broster and Norton 1992, 1993; Broster et al. 1994; Goodyear and Steffy 2003; Gramly and Yahnig 1991; McAvoy 1992; Miller 2007) has led to the reevaluation of the nature of Clovis settlement. Anderson’s (1990, 1995, 1996) staging-area model in particular attempts to explain the spread of Clovis technology by means of human migrations, but at a much slower pace than the HTF model. Anderson argues that high-technology colonizing groups immediately encountered major river systems that eventually led them to three major river valleys in the south and east─the Ohio, Cumberland, and Tennessee River valleys. Once in these valleys, group migrations slowed. Based on dense concentrations of fluted points, Anderson (1996:36) suggests that groups settled into resource-rich locations, staging areas where populations habitually exploited local toolstone and a wide range of biotic resources, and aggregated for information and mate exchange. As population sizes increased, groups fissioned and dispersed to secondary staging areas, for example valleys in the Atlantic Coastal Plain (Anderson 1990, 1995, 1996), where the process was repeated. These initial and later population concentrations became the foundation for early cultural regionalization (Figure 38) (Anderson 1996:35).

Anderson's (1996) staging-area model of Clovis dispersal in the Southeast accounts for dense concentrations of isolated points in major river valleys by suggesting that groups slowed the process of dispersal in these areas. These resource-rich locations became staging areas where discrete populations concentrated activities and settled-in for years or even generations, periods certainly longer than predicted by the HTF model. Groups residing in these core areas became familiar with the local environment and habitually used resources in their homeland (Anderson 1990, 1995, 1996). The staging-area model investigates the nature of early settlement systems, but does not directly describe the lithic assemblages that reflect this settlement strategy.

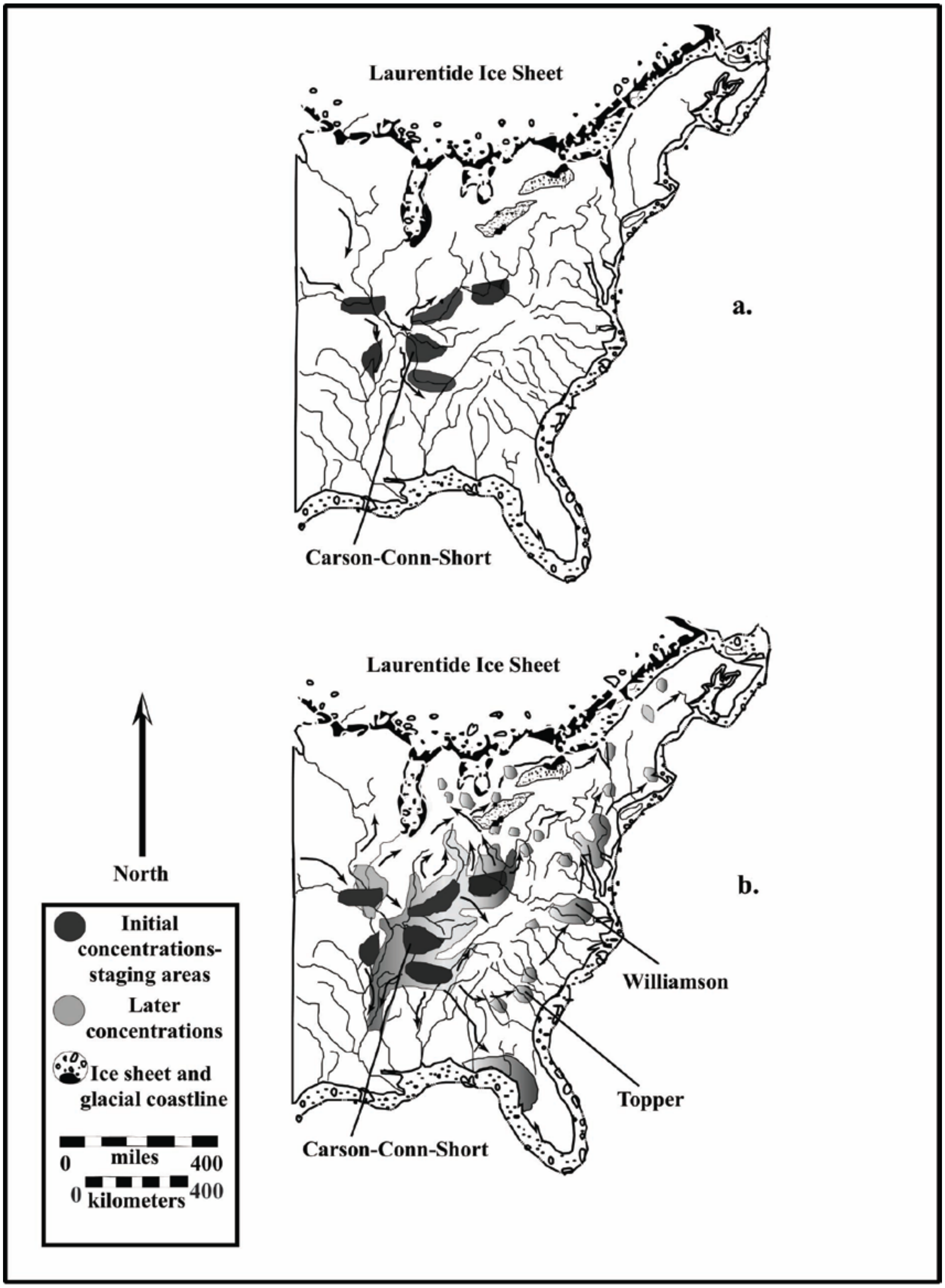


Figure 38. Maps showing locations of archaeological sites included in this study and Anderson's hypothesized staging areas (a. initial concentrations; b. later concentrations).

There are testable implications, however. The model proposes increasing regionalization caused by relative permanence in initial and later staging areas. Therefore, heterogeneity should be evident between assemblages from different population concentrations, especially between finished point forms and the processes of their manufacture. Despite the limited number of ^{14}C dates from Paleoindian sites in the Southeast, timing is a significant aspect of this model. Southeastern Clovis sites may be contemporaneous to Waters and Stafford's (2007) recently narrowed window of Clovis occupation, 11,050 to 10,800 ^{14}C yr B.P., suggesting a minimum span of 400 years. Without reliable ^{14}C dates from the region, though, we must rely on studies of occupation duration that may help shed light on the problem, as Dibble and Rolland (1992), Parry and Kelly (1988), and Sullivan (1992) have previously done in other contexts. Based on implications of Anderson's model, I investigate whether Clovis groups actually settled into core areas of the Southeast by evaluating whether stylistic and technological differences exist between regions, which may indicate early cultural regionalization, reduced territorial ranges, and increased durations of occupation in subregions (Anderson 1990).

Testing Clovis Mobility Models in the American Southeast

The Carson-Conn-Short, Topper, and Williamson sites are ideal locations to identify patterns in reduction sequence and point morphology in the three proposed staging areas. First, all three are procurement locations, where stone was readily accessible. This ensures that availability of raw material did not constrain the reduction sequence. Second, the three Clovis assemblages contain manufacturing debris that can help reconstruct and identify patterns in reduction strategies. Third, all three assemblages contain numerous bifaces, preforms, and points, so that a more comprehensive understanding of point morphology can be traced; the intended style and shape is evident in the unbroken preforms, and shapes caused by use and rejuvenation are evident in exhausted, discarded points. As proposed in the staging-area model, each of these sites is a source of high-quality chert found within a major river valley that likely was rich in biotic resources during the late Pleistocene, places where Clovis groups may have settled for extended periods of time (Anderson 1996).

Study Areas

Carson-Conn-Short Site, *Tennessee (40BN190)*. Carson-Conn-Short (CCS) falls within a hypothesized initial staging area (Figure 38) (Anderson 1996). It is located on the edge of the Western Valley physiographic region, in a series of terrace ridges along the shore of Kentucky Lake and south of an ancient channel of the Tennessee River (Broster and Norton 1993; Broster et al. 1996). Modern plowing loosened the topsoil on the site, and construction of Kentucky Lake in 1941 led to regular flooding causing artifacts to become exposed in an embayment area. Artifacts on the surface were initially found and donated by three local amateur archaeologists (the site’s namesakes), and the site was recorded and collected by archaeologists Broster and Norton. In 1992 and 1993, Broster, Norton, Stanford, and Jodry systematically excavated for intact Paleoindian components (Broster et al. 1996).

During the late Pleistocene, the environment around CCS was mesic deciduous forest (Delcourt and Delcourt 1985). During the Clovis occupation and prior to the creation of Kentucky Lake, the site was positioned on a dry elevated terrace along a freshwater creek, a short distance from the Tennessee River channel. Clovis people at CCS would have had access to aquatic resources and large herd animals drawn to the swampy areas for water and forage (Breitburg and Broster 1994; Broster and Norton 1996), as well as high-quality Fort Payne chert cobbles and tabular pieces that were available along the river (Broster et al. 1994). Once the Tennessee channel shifted, younger cultural components (e.g., Mississippian) situated on the first terrace of the new channel blocked and prevented erosion of the Clovis deposits in the embayment (Broster, personal communication 2009).

Carson-Conn-Short is located near large primary sources of Buffalo River chert, a local variety of the Fort Payne chert formation. The outcrop is a series of extensive deposits with chert formed in veins and tabular nodules that vary between 30 to 50 mm in thickness (Nami et al. 1996). Clovis flintknappers quarried the blocky sub-rectangular nodules.

Long-term or repeated use of the source led to the production of an extensive workshop site, but Clovis occupation areas seem horizontally separated and stratigraphically deeper than smaller late Paleoindian (e.g., Cumberland, Quad/Beaver Lake, and Dalton) and Archaic (e.g., Big Sandy and Ledbetter) occupation areas.

Artifact features or concentrations were noted in seven separate site localities, all situated on high peaks of inactive Tennessee River terraces, and in some of these localities, the Clovis occupation is buried 45 to 68 cm below surface (Broster et al. 1994). The intact Clovis deposits encountered in 10 separate test units yielded artifacts indicative of the production of fluted projectile points and prismatic blades (Broster and Norton 1993, 1996; Broster et al. 1994). To date, approximately 4691catalogued artifacts have been recovered from surface surveys, and 582 artifacts (including 350 tools and cores) have been recovered from excavations (Broster et al. 1996). There are 38 known complete Clovis points. The CCS collection is curated and analyzed at the Tennessee Division of Archaeology. For this study, I analyzed eight Clovis points and 124 bifaces from the Carson-Conn-Short site.

Topper Site, Allendale County, South Carolina (38AL23). Anderson (1996) designates the area surrounding Topper as a secondary staging area, occupied once groups fissioned from the initial staging area (Figure 38). Topper is located in the central Savannah River valley of the Atlantic Coastal Plain. During the late Pleistocene, Topper existed at the intersection of two major ecosystems, the southern-most limit of a cool and mesic deciduous forest, and the northernmost limit of the warmer, temperate southeastern evergreen forest (Delcourt and Delcourt 1985, 1987; Delcourt et al. 1983; Goodyear et al. 1990). Topper is a multi-component procurement-related site situated on a sandy terrace above a natural outcrop of Coastal Plain chert (Goodyear and Charles 1984). 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). Clovis artifacts have been found in both areas, as well as in the Savannah River bottom (Waters et al. 2009).

Topper Allendale Coastal Plain chert outcrops on the hillside and at the bottom of the river channel. Rounded nodules have maximum diameters ranging from 300 to 500 mm, but they often have voids and flaws (Goodyear, personal communication 2010) that led to variation in potential biface size (Smallwood 2010).

The high integrity of the buried Clovis component has been demonstrated by spatial analysis and refit studies (Miller 2007; Smallwood et al. 2008). Large block excavations (totaling more than 500 m^2) have produced four Clovis points, 174 bifaces and preforms, an extensive unifacial tool collection with scrapers and blades, and large quantities of debitage (Goodyear 2005a, 2006; Goodyear et al. 2007; Smallwood 2010). Further, the site is one of only two excavated Clovis sites in the Atlantic Coastal Plain of Georgia and the Carolinas; the other is Big Pine Tree (38AL143), located approximately 2 km up the Savannah River valley from Topper (Goodyear 1999; 2005b). The Topper assemblage is permanently curated at the South Carolina Institute of Archaeology. For this study, I analyzed four Clovis points and 139 bifaces from the Topper site.

Williamson Site, Dinwiddie County, Virginia (44DW1). The Williamson site falls within an area theorized by Anderson as a later Clovis staging area, and is situated at the interface of the Coastal Plain and Piedmont physiographic regions, between the

Nottoway and Appomattox River basins (Figure 38) (Anderson 1996; Peck 2004). During the late Pleistocene, Williamson was located in the southeastern portion of the northern boreal forest, just beyond the more mesic deciduous forest to the south (Delcourt and Delcourt 1985). The site rests on the south side of Little Cattail Creek, where primary and secondary sources of variegated chalcedony outcrop (Callahan 1979; Hill 1997; Peck 2004).

The extensive local outcrops of raw material, described as “Little Cattail Creek chalcedony” and “Williamson chert” (McAvoy 1992; McCary 1975), are part of a formation comprised of chalcedony, chert, and jasper with small pockets of quartz (McAvoy 1992, McCary 1975). The most sizeable irregular blocks of chert on the Williamson site measure as much as 250 mm in length and can weigh up to 45 pounds. However, the majority of the material occurs as fractured pebble- and cobble-sized blocks (approximately 250-300 mm in size) eroded out of the creek along sloping banks and also worn in the creek bottom (McAvoy, personal communication 2010).

Williamson is a large workshop and habitation site with Paleoindian artifacts distributed over more than 4600 m^2 (Peck 2004). The upland portion of the site is disturbed due to modern agricultural practices; uncontrolled surface collection in this area produced an impressive assemblage of artifacts (Hill 1997; Peck 1985, 2004). Additionally, four subsurface examinations confirmed that Williamson has buried cultural deposits on the hillside slope (Haynes 1972), a stratigraphically distinct fluted-point component (Benthall and McCary 1973; McAvoy 1992), and intrasite variation of activity areas representing camp and production tasks (Hill 1997). The sheer quantity of

Clovis artifacts in this area suggests the significance of the location to Clovis people and the key role it may have played in their settlement system (McCary 1975). Hill (1997) excavated a collection of 4551 artifacts, with 314 tools, unfinished bifaces, and cores. The total tool assemblage consists of an estimated 150-170 fluted projectile points, 800-1000 end scrapers, and a variety of other tool types. The majority of the Williamson collection is currently in the possession of R. Peck, including a portion of McCary's excavated and surface collections, and the remaining portion is curated at the College of William and Mary. For this study, I analyzed 115 Clovis points and 166 bifaces from the Williamson site.

Paleoindian Database of the Americas (PIDBA). PIDBA provides raw material and metric data for isolated fluted points found in the subregions. This dataset substantially supplements the site assemblages with information on privately-owned and museum-owned fluted points. While PIDBA contains data contributed by multiple researchers, so there is a chance for inter-observer error (Prasciunas 2008), it contains valuable data typically not available to individual researchers (Anderson et al. 2005, 2010). For this analysis, I included Clovis points from databases recorded by county for the states of Mississippi, Alabama, Georgia, South Carolina, North Carolina, Virginia, Kentucky, and Tennessee. All points used in this study were specifically typed as fluted Clovis points by regional experts, and no untyped fluted or fluted variants (e.g., "Clovis-like" and "unfluted Clovis") were included.

I incorporated a sample of 683 Clovis points from the Carson-Conn-Short subregion; this includes eight points from Carson-Conn-Short and 675 points from PIDBA. From the subregion surrounding the Topper site, I analyzed a total of 304 Clovis points, including four points from Topper, 24 points I studied firsthand from the Smithsonian Georgia School House collection originally found in Burke, Richmond, and Columbia counties along the Savannah River border and now curated at the Smithsonian Institute (Stanford, personal communication 2010), and 276 points from PIDBA. The Williamson subregion dataset totals 506 points and was comprised of 115 points from Williamson (75 from the Peck Collection and 40 from the McCary collection at the College of William and Mary), and 391points from the PIDBA database.

Expectations of Mobility Models

This study tests the staging-area model through analysis of Clovis biface assemblages and considers if the primary alternative model, the high-technology forager model, is more fitting to explain Clovis settlement in the American Southeast. The assemblages from Carson-Conn-Short, Topper, and Williamson contain the materials needed to test the staging-area model against other models of Clovis settlement.

As a rapid-mobility model, the HTF model predicts homogeneity in technology and precludes regional distinctions (Kelly and Todd 1988). Therefore, if the HTF model is a fitting explanation of Clovis dispersal in the Southeast, then I expect to see no variation in point morphology, and biface technology should be indistinguishable among the three Clovis assemblages. If the staging-area model is an accurate assessment of dispersal, then I expect relatively more heterogeneity between the biface assemblages from the three sites than predicted by HTF. This heterogeneity would be the product of population fissioning, followed by discrete groups settling into new areas and reducing territorial ranges. This process would have stylistic and technological implications for the assemblages from each population concentration. To analyze similarities and differences in technology I assess variation among (1) Clovis points from each potential population concentration and (2) systems of biface manufacture at each procurement-related site.

In Anderson’s model, the settlement of staging areas played a major role in shaping early cultural traditions, and this proposed emerging regional variation implies testable expectations for point morphology. Analysis of metric attributes of projectile points from the three Southeast site areas facilitates examination of regional style variation within Clovis points (Frison 1978, 1991; Willig 1991). If Clovis groups fissioned into discrete populations and settled in for long periods, I expect to see more morphological variation between Clovis points from these three population concentrations than expected by the HTF model (Faught 2006; Goodyear 1999; Lepper and Meltzer 1991; Tankersley 1991). To test this expectation, morphological variation is based on measurements of point attributes, such as degree of excurvature of the blade element (basal width:body width) and degree of concavity at the point base. These measurements are compared to attribute averages calculated based on measurements from the PIDBA database of isolated point finds associated with the entire Southeast sample, or the average point measurements from the region as a whole. Stylistic variation in point technology was also examined by comparing point shapes (Morrow and Morrow 1999).

Anderson’s (1996) model also predicts populations resided in staging areas for years or even generations, and this long-term occupation and population concentration implies testable expectations for biface technology. An analysis of the bifacial reduction sequence allows for an understanding of manufacturing strategies (Andrefsky 2005; Lothrop 1989). If these site areas represent discrete population concentrations, there should be distinct manufacturing signatures, or techniques that differentiate bifacial tool technologies represented at each site. Distinctions can be detected, for example, by analyzing the incidence of overshot flaking and the manner and timing of end-thinning in the production sequence (Morrow 1995, 1996).

Unique features of raw materials could have affected aspects of tool reduction, especially in the initial steps of the decision-making process involved in biface production. Specifically, characteristics such as material blank type, extent of cortex, and transverse cross-section, as well as simple size measurements (e.g., biface length, width, and thickness) are all traits plausibly affected by initial material source conditions. The impact of raw material characteristics in creating the Clovis point form and technology are considered in the analysis.

Methods

Methods for Analysis of Point Morphology

A total of 1493 Clovis points was used to test for regional style variability. This dataset included points found at the three sites and was supplemented using isolated points of the same raw-material sources from PIDBA. Point morphology was measured using a standard series of metric values: total length, maximum body width, basal width, maximum thickness, and basal concavity depth, (Goodyear et al. 1983; Morrow and Morrow 1999; Thulman 2007). Points were compared based on shape ratios like length:width and width:thickness. Morphological equations developed by Morrow and Morrow (1999) were used to measure degree of excurvature of the blade (basal width:maximum width) and indentation of the basal edge (basal concavity depth:basal width). Because the data were not normally distributed, values from each staging area were compared using nonparametric Kruskal-Wallis tests and post-hoc pairwise Mann-Whitney/Wilcoxon Ranked Sum tests to determine whether significant statistical relationships occurred between the three staging areas. The analysis also compares variation of metric attributes within each potential staging area to determine the aspects of point morphology that vary most and to consider what this variation means. A coefficient of variation was calculated by dividing each characteristic sample standard deviation by the sample mean and multiplying the value by 100 to produce the percent of variation (Bever and Meltzer 2007; Eerkens and Bettinger 2001; Taylor-Montoya 2007).

The average values for the Carson-Conn-Short, Topper, and Williamson staging areas were also compared to values of a “regionally average point”—in other words, the averaged measurement calculated for each attribute of Clovis points from PIDBA databases recorded by county for Mississippi, Alabama, Georgia, South Carolina, North Carolina, Virginia, Kentucky, and Tennessee. The regionally average point sample is comprised of a total of 2851 Clovis points and excludes those points crafted from raw materials local to each staging-area, as these points are included in staging-area samples.

Methods for Analysis of Biface Technology

To understand biface technology I analyzed preforms, bifaces, and biface fragments from the three sites. A total of 463 bifaces and biface fragments were analyzed to compare tool forms and manufacturing strategies. First, I assigned bifaces to three successive reduction stages (early, middle, and late) based on presence or absence of cortex, extent of flaking, edge sinuosity, flake-removal technique (Waters et al. 2011), and flaking index. These variables helped quantify extent of reduction (Miller 2007; Smallwood 2010). The values of metric attributes and ratios (e.g., length:width and basal width:body width) for bifaces by stage of reduction for each potential staging area were also compared using nonparametric multiple and pairwise tests. I also recorded descriptive categorical variables such as the extent of cortex, blank type (e.g., biface core or flake spall) (Sanders 1990), transverse cross-section, planview, and edge shape. Reconstruction of preform production was accomplished through an analysis of the number and direction of thinning techniques. Distinctions in biface reduction strategies were based on the frequency of 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 overshot flaking (thinning flakes that extended past the center line to the opposite lateral margin, removing the opposite lateral margin) and timing in the reduction sequence where end-thinning occurred (flaking that originates at the end of a biface and extends parallel to its long-axis) (Bradley 1993; Collins et al. 2003; Smallwood 2010). The statistical significance of the relationship between the potential staging areas and these categorical variables was compared for each stage of biface reduction. Finally, I analyzed width and thickness reduction patterns by calculating the percent lost after each stage of reduction, using the following formula: n = 100 – 100 (average body width for middle-stage bifaces/ average body width for early-stage bifaces) where n = the percent lost in reduction.

Results

Point Morphology

Due to small sample sizes, Clovis points specifically from the three sites could not be statistically compared without including the larger PIDBA sample. Nonetheless, point averages for each site are presented separate from regional-scale point comparisons, which include points from the three sites as well as surrounding subregions.

Points from Main Study Sites. The eight Clovis points analyzed from Carson-Conn-Short are made on Fort Payne chert (Table 12, Figure 39, g-j). Three are complete and five are incomplete. The four Clovis points from Topper are all fragmented (Figure 40, g-i). Two are crafted from Coastal Plain chert, one is made on quartz-plagioclase-porphyritic rhyolite, and the other is made on black rhyolite. Of the 115 points from Williamson, 75 are crafted on chalcedony, 34 on quartz, five on coarse-grained quartzite, three on chert, and one on jasper (Figure 41, g-j). Forty-nine points are complete. Overall, size and shape averages for each of the three sites are comparable to averages calculated for the total point sample, which includes Clovis points from the PIDBA dataset. The differences between the site-level datasets correspond to patterns in the regional point samples.

Table 12. Clovis Finished Point Comparisons.

Staging-Area Clovis Finished Point Measurements (Main Study Site Averages and Regional Point Averages in mm)	Carson-Conn-Short n = (8)[a] 675	Topper n = (4) 300	Williamson n = (115) 391	Average Southeastern Clovis Point (n = 2,851)
Length	(62.62) 70.59	(n/a) 58.49	(43.90) 50.97	60.20
Width	(29.45) 29.42	(27.21) 26.73	(24.51) 24.79	26.99
Thickness	(7.94) 6.99	(6.62) 7.11	(7.08) 7.03	7.02
Basal Width	(26.36) 26.24	(26.17) 23.90	(22.27) 22.32	24.90
Length: Width	(2.06) 2.53	(n/a) 2.22	(1.94) 2.10	2.23
Width: Thickness	(3.76) 4.26	(4.11) 3.88	(3.52) 3.66	3.84
Basal Width: Width	(0.92) 0.90	(0.96) 0.90	(0.94) 0.94	0.92
Depth of Concavity	(3.20) 3.75	(3.20) 3.24	(2.77) 3.04	3.53
Depth of Concavity: Basal Width	(0.12) 0.15	(0.10) 0.14	(0.13) 0.12	0.14
Depth of Concavity: Dominant Flute Length	(0.12) 0.15	(n/a) 0.15	(0.14) 0.15	n/a
Dominant Flute Length: Length	(0.41) 0.42	(n/a) 0.43	(0.45) 0.41	n/a

[a] Values in parentheses represent counts and average values for points found at main study sites.

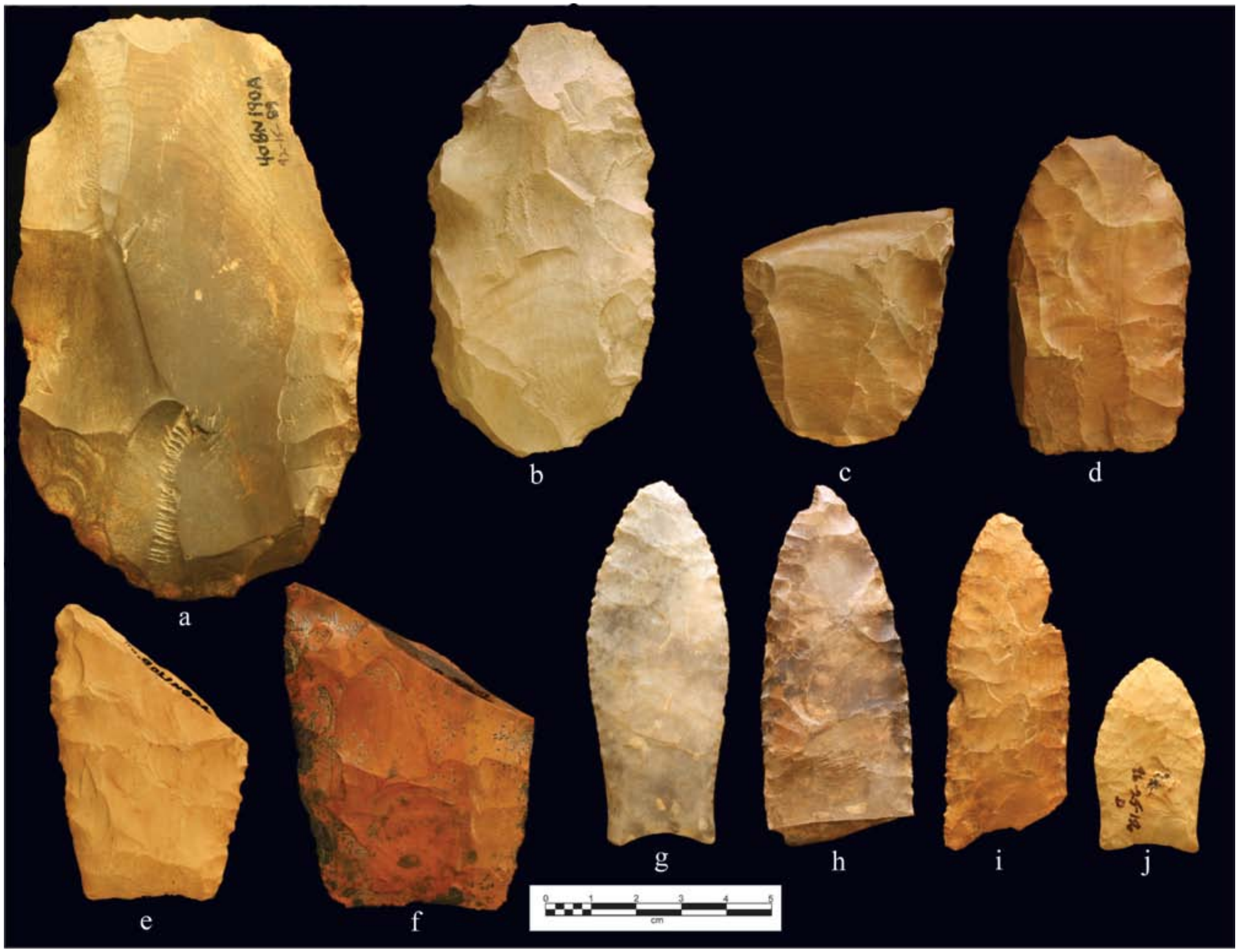


Figure 39. Clovis lithic artifacts from the Carson-Conn-Short site: (a-b) early stage bifaces; (c-d) middle stage bifaces; (e-f) late-stage biface; (g-j) finished points.

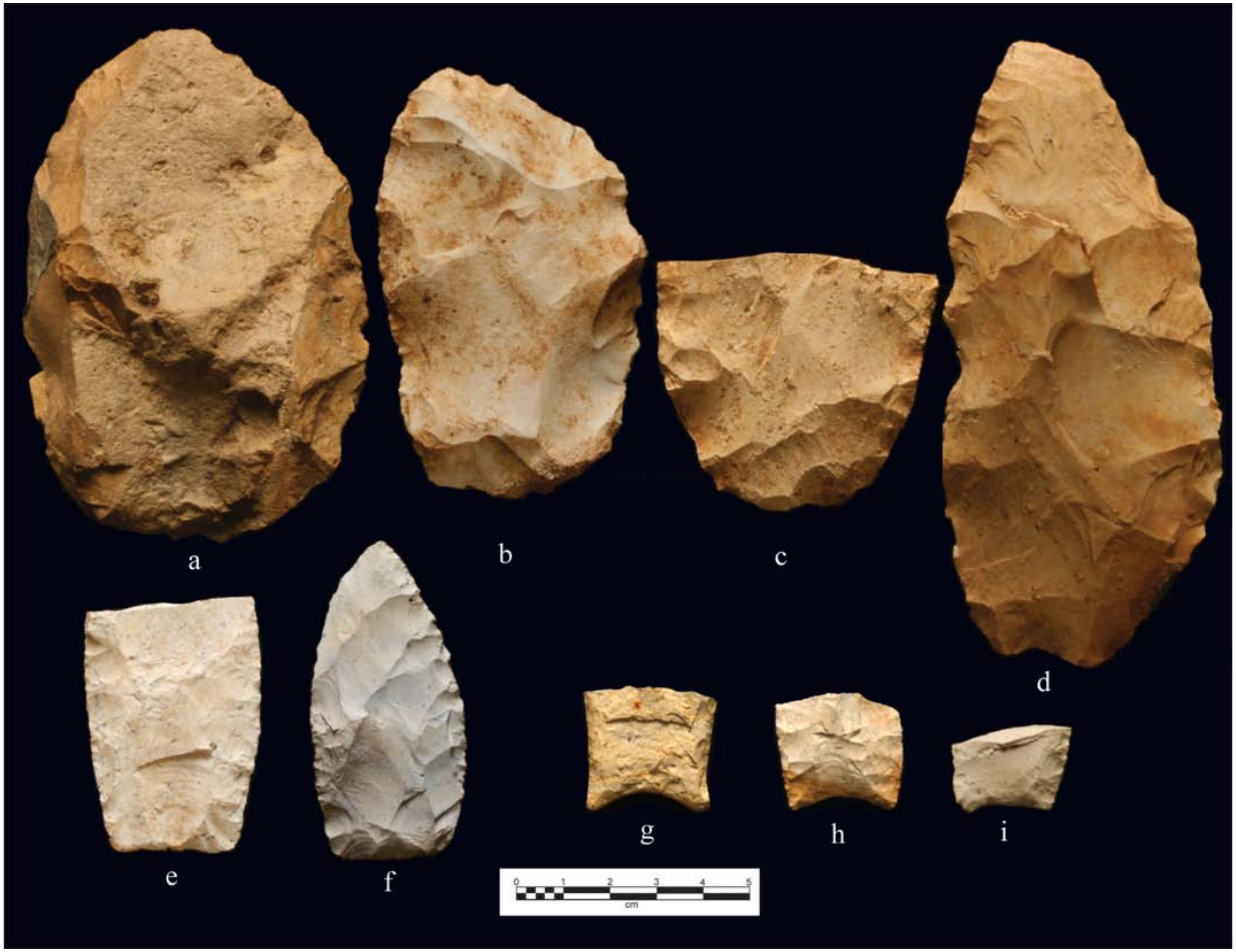


Figure 40. Clovis lithic artifacts from the Topper site: (a-b) early stage bifaces; (c-d) middle stage bifaces; (e-f) late-stage biface; (g-i) finished points.

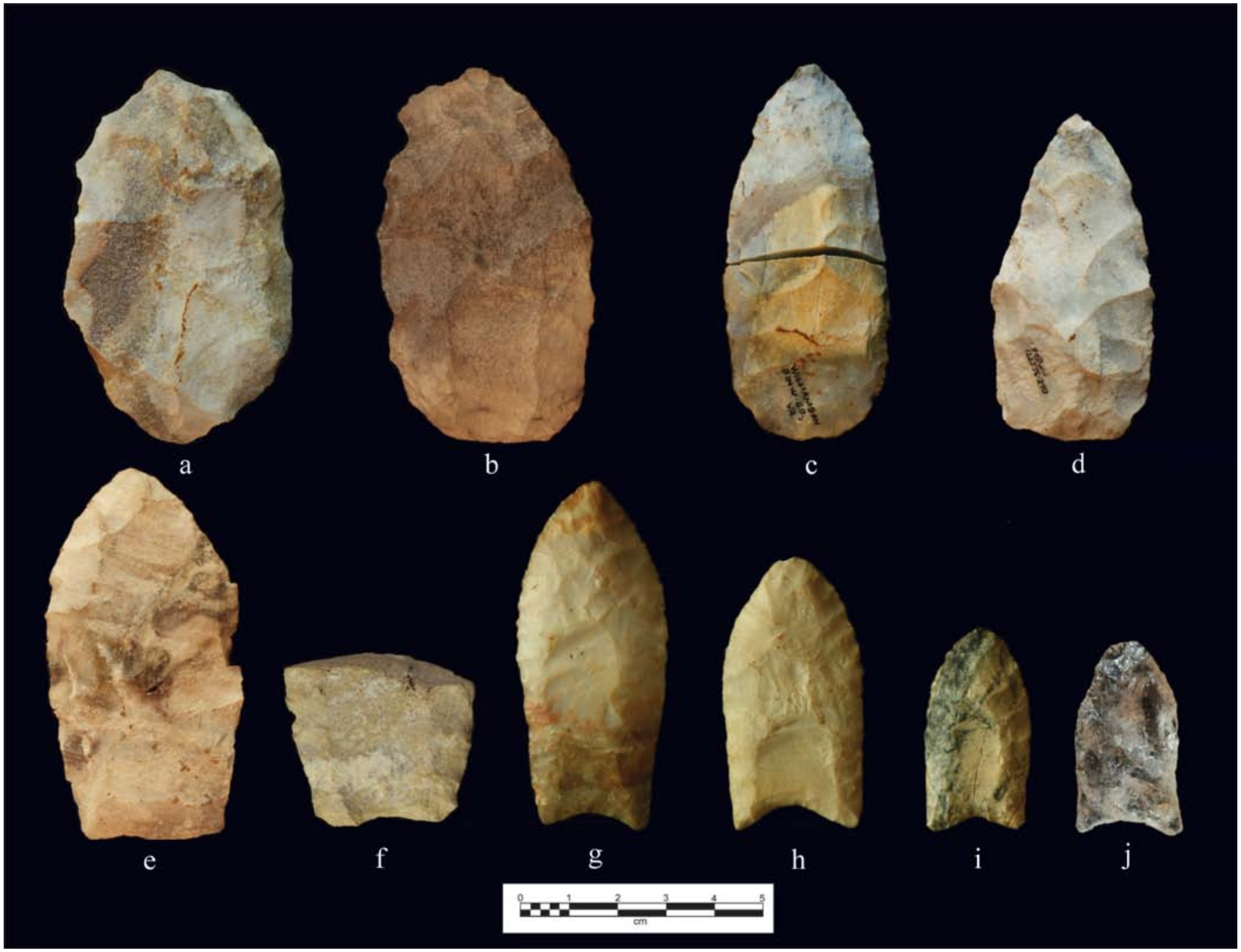


Figure 41. Clovis lithic artifacts from the Williamson site: (a-b) early stage bifaces; (c-d) middle stage bifaces; (e-f) late-stage biface; (g-j) finished points.

Points from Potential Staging Areas. The total sample of 1493 Clovis points was analyzed using multiple and pair-wise comparisons of sizes and shapes between the three potential staging-areas (Table 12). Point sizes produced a standard pattern of significant variation in point lengths and widths ($p < 0.000$ for both variables) (Figure 5). On average, points from the Carson-Conn-Short subregion are significantly longer than points from the other subregions—12.1 mm longer than the Topper area points and 19.6 mm longer than Williamson area points. Carson-Conn-Short points are also widest, while Williamson points are the narrowest. Carson-Conn-Short points are 2.7 mm wider than Topper points and 4.63 mm wider than Williamson points. Likewise, Carson-Conn-Short point bases are 2.34 mm and 3.92 mm wider than Topper and Williamson point bases, respectively (CCS vs. TP, $p < 0.000$; CCS vs. WM, $p < 0.000$; and TP vs. WM, $p = 0.006$) (Figure 42). Interestingly, when point thickness is evaluated the outcome is much different. No matter the size, points from the three subregions are equally thin ($p = 0.145$).

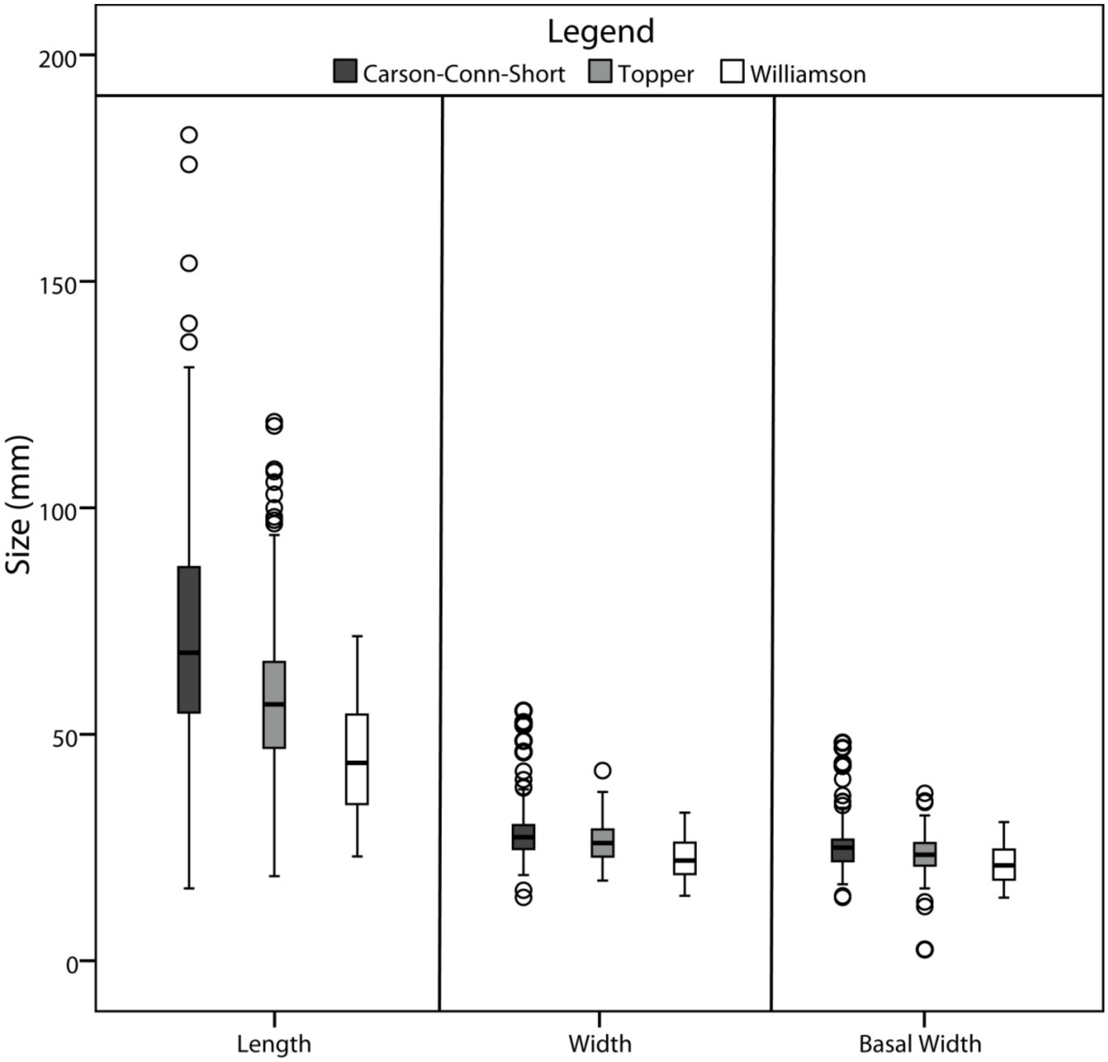


Figure 42. Boxplots comparing Clovis finished point lengths (left), widths (middle), and basal widths (right) from the three potential staging areas. Boxes represent the interquartile range comprised of 50% of the cases. Black lines are medians. Circles represent outliers.

When shape ratios involving body width are considered, points from the Carson-Conn-Short subregion continue to be most robust, and Williamson points least robust (Table 12) (Figure 43). Interestingly, however, ratio comparisons indicate significant differences in shape proportions. In terms of length-to-width ratio, Carson-Conn-Short points are slender but long, while Topper and Willamson points are comparatively wide but short (*p* < 0.00). This size trend continues when the ratio of width-to-thickness is evaluated, with Carson-Conn-Short point shapes being significantly thinner relative to width (*p* < 0.00).

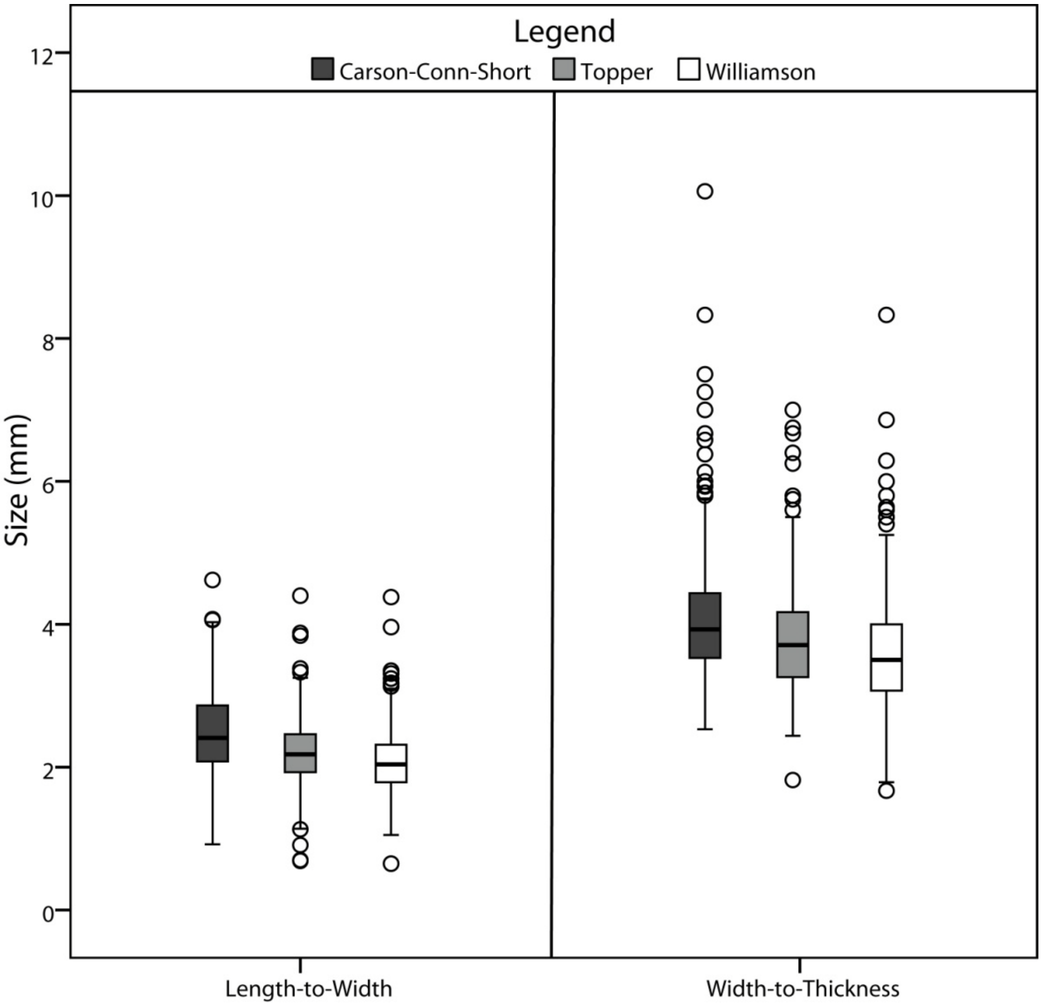


Figure 43. Boxplots comparing Clovis finished point ratios length-to-width (left) and width-tothickness (right) from the three potential staging areas. Boxes represent the interquartile range comprised of 50% of the cases. Black lines are medians. Circles represent outliers.

Ratios featuring basal features reflect a decidedly different pattern (Table 12). Depth of concavity for Carson-Conn-Short area points is significantly more concave than Topper ($p = 0.01$) and Williamson ($p < 0.00$) points, but Topper and Williamson depths of concavity do not differ significantly. Interestingly, ratio of depth-of-basal-concavity-to-basal-width follows a different pattern (Figure 44), with the average value for Carson-Conn-Short being significantly higher than Topper ($p = 0.03$) and higher (but not significantly) than Williamson ($p = 0.055$). Thus, Carson-Conn-Short points have more deeply concave bases relative to their basal widths.

Degree of blade excurvature, or basal-width-to-body-width, follows a different trend (Table 12) (Figure 45). Williamson's blade excurvation ratio is significantly higher than Carson-Conn-Short ($p < 0.00$) and Topper ($p < 0.00$). In other words, Williamson point outlines are straight, while Carson Conn Short and Topper expand more from the base upwards. The ratios of dominant-flute-length-to-point-length and basal-depth-to-dominant-flute-length do not differ significantly among the assemblages ($p = 0.728$, $p = 0.759$, respectively).

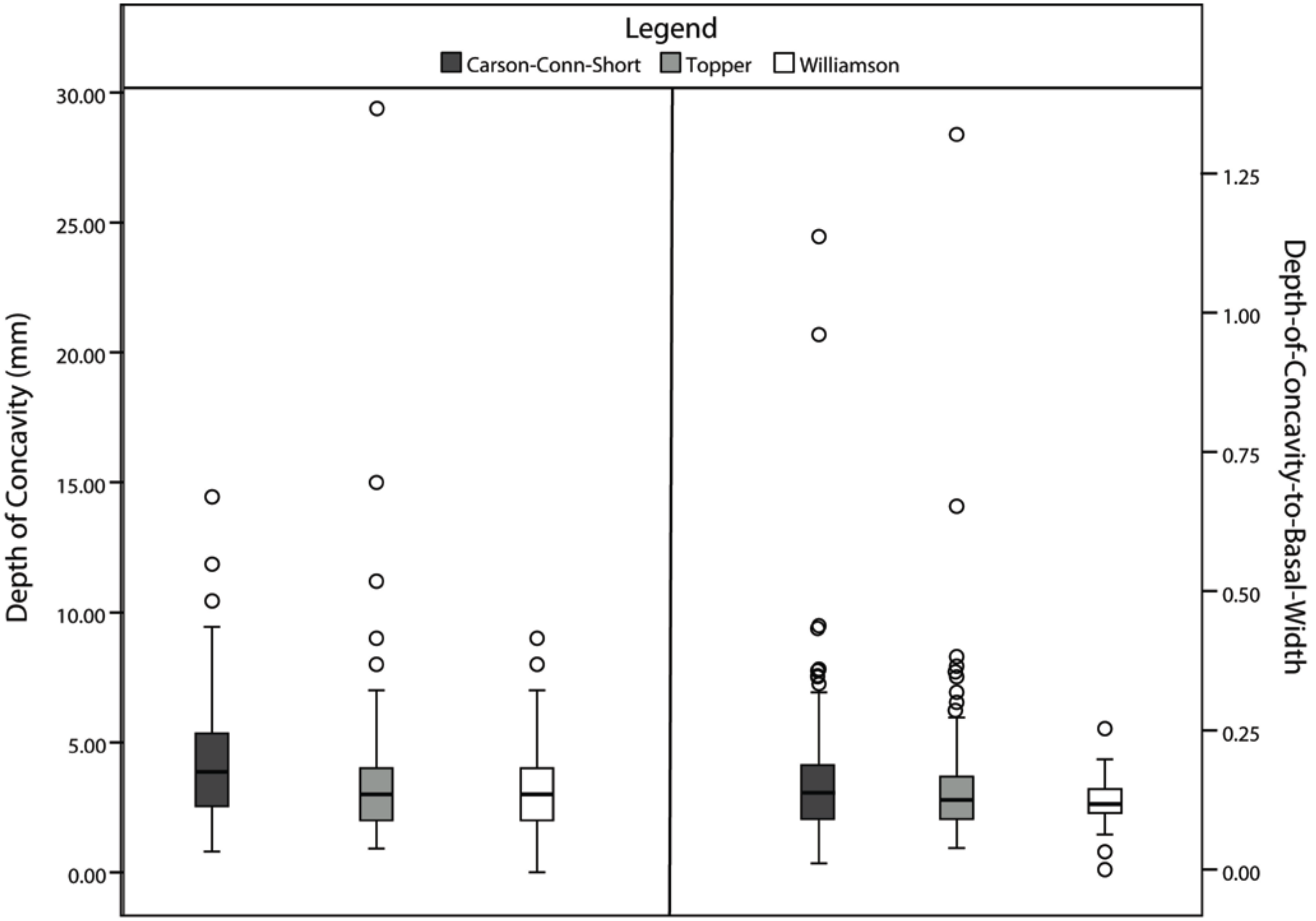


Figure 44. Boxplots comparing Clovis finished point depth of concavity (left) and ratio of depth of-concavity-to-basal-width (right) from the three potential staging areas. Boxes represent the interquartile range comprised of 50% of the cases. Black lines are medians. Circles represent outliers.

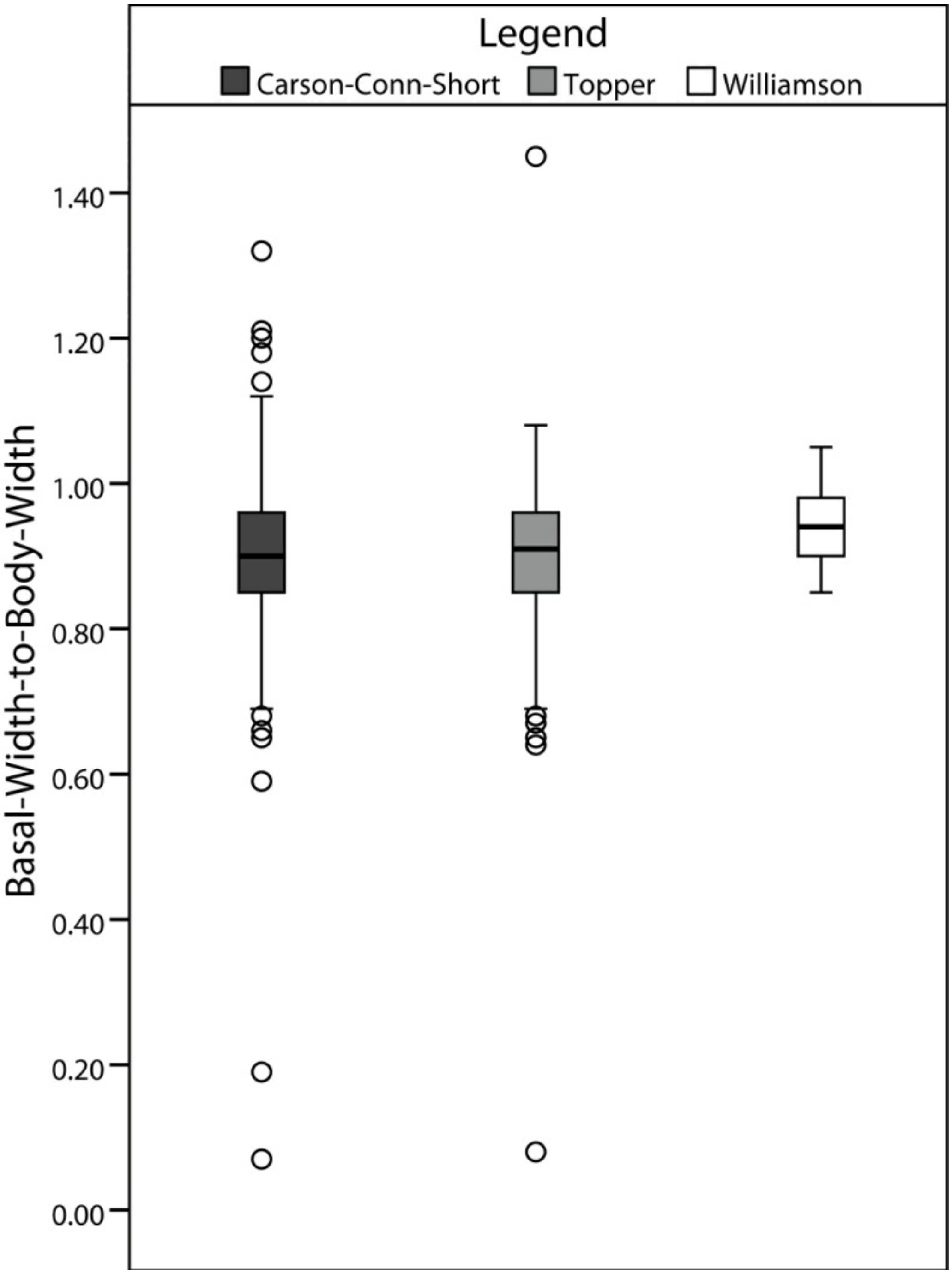


Figure 45. Boxplots comparing Clovis finished point ratios of basal-width-to-body-width for the three potential staging areas. Boxes represent the interquartile range comprised of 50% of the cases. Black lines are medians. Circles represent outliers.

In an analysis of variation within metric samples from each potential staging area, some attributes vary more than others (Table 13). Most of the point size and shape attributes show little variation and have coefficient values of less than 30%. Of the size attributes, length is the most variable, but this variability is still surprisingly low (less than 35%) given effects of use damage, resharpening, and reworking. Coefficient of variation measures are highest for factors involving depth of basal concavity. Depth of concavity and ratios of concavity-to-basal-width and concavity-to-maximum-flute-length all vary to a greater degree relative to other point variables. This suggests that concavity was either situationally affected from variance in use and reworking or was not as functionally significant as other point attributes and was flexibly applied (see Taylor-Montoya 2007).

To determine if any of the staging-area point averages are regional outliers, each was compared to regional values. While these relationships are relative, interesting patterns that generally mimic the pair-wise staging-area comparisons are evident. When size measurements of length and width are evaluated, points from the Topper region cluster with the regionally average point (Figure 46a-b) (Table 12). Points from the Carson-Conn-Short subregion are decidedly longer and wider and Williamson points are shortest and narrowest.

Table 13. Clovis Finished Point Comparisons of Coefficient of Variance.

Staging-Area	Carson-Conn-Short	Topper	Williamson
Clovis Finished Point (variance in %)	(n = 683)	(n = 307)	(n = 506)
Length	34.11	29.42	31.90
Width	24.75	15.23	18.23
Thickness	25.61	20.11	23.76
Basal Width	22.07	15.98	18.59
Length: Width	24.11	22.07	21.43
Width: Thickness	22.54	23.91	23.22
Basal Width: Width	12.22	11.11	5.32
Depth of Concavity	61.6	52.16	43.75
Depth of Concavity: Basal Width	60.00	71.43	33.33
Depth of Concavity: Dominant Flute Length	60.00	66.67	46.67
Dominant Flute Length: Length	39.60	37.13	36.81

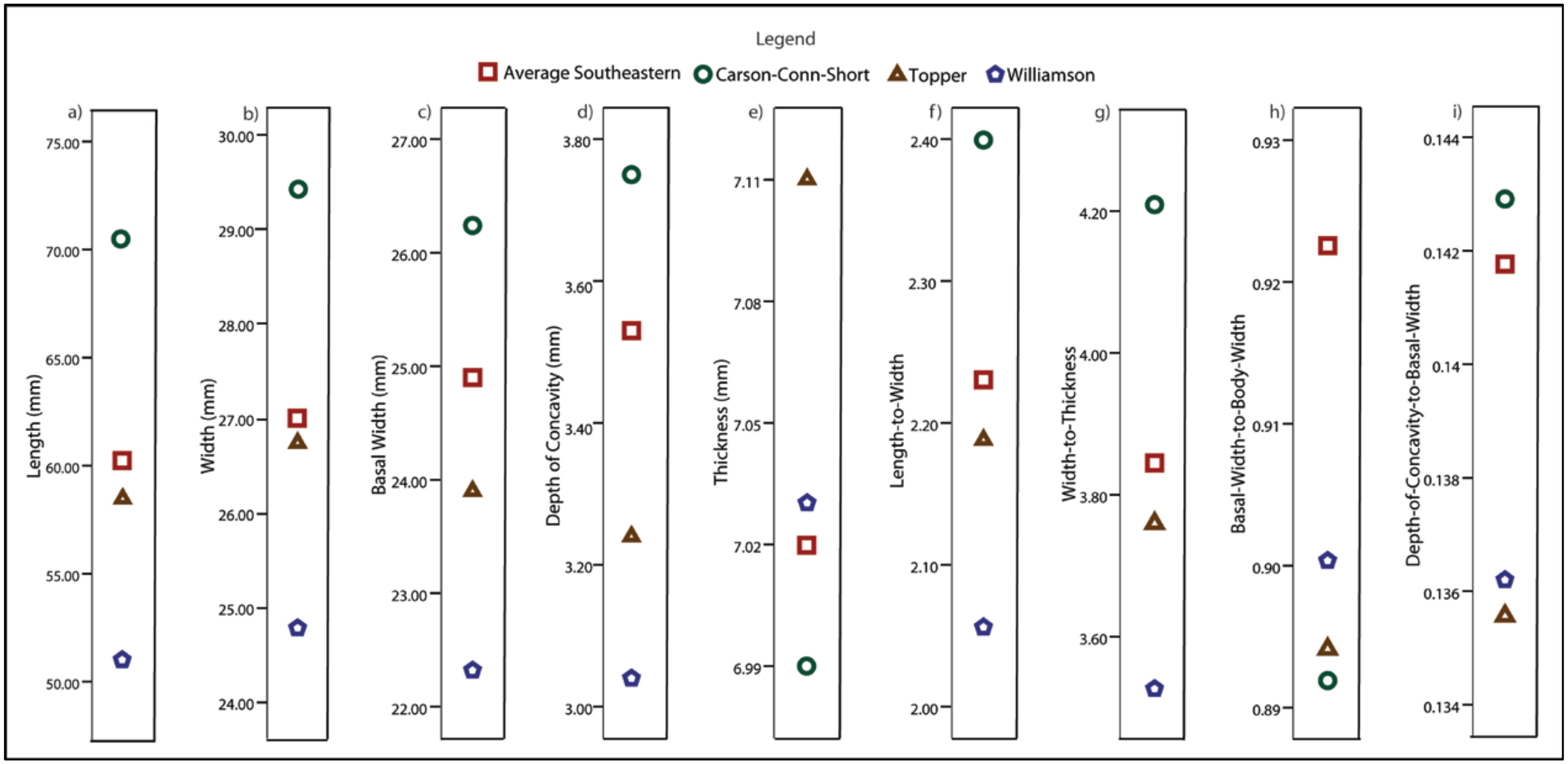


Figure 46. Plots comparing Clovis finished point variables from the three potential staging areas to the regionally average point based on the ratio of length-to-width and measurements of basal width and depth of concavity.

When mean basal widths are compared, the decreasing size trend continues, but with a slightly different pattern (Figure 46c) (Table 12). Carson-Conn-Short points are the widest and greater than the regionally average point, Topper points average narrower, and again, the Williamson average is decidedly narrower than the others. Based on basal concavity depth, Carson-Conn-Short points have the deepest basal concavities (Figure 46d). Comparisons of thickness change the size trend. Points from the Williamson area are most similar to the regionally average point, Topper area points are much thicker, and Carson-Conn-Short points are thinnest (Figure 46e).

Shape ratios of length-to-width and width-to-thickness follow the expected pattern based on the standard metric trends (Figure 46f-g). For both shape ratios, the Topper average is most similar to the regionally average point. Again, Carson-Conn-Short points are robust and Williamson are smallest in shape. Shape ratios that consider basal features produce very distinct relative trends (Table 12). Based on the ratio of basal-width-to-body-width, averages from the three potential staging-areas are very similar; the regionally average point is the outlier (Figure 46h). The average Southeast point is widest at the base relative to body width. The average points from the Topper and Carson-Conn-Short staging areas are comparatively the narrowest at the base. Interestingly, based on basal-depth-to-basal-width the average Williamson point is the shape outlier, with a proportionately smaller or shallower depth of basal concavity relative to basal width (Figure 46i).

Analysis of Clovis point morphology indicates there may be nuances of variation within what archaeologists consider to be the standard Clovis form. There are significant differences in point sizes and shapes. Carson-Conn-Short points are robust, Williamson points are least robust, and Topper falls between the two. Unique basal features also distinguish the points. Carson-Conn-Short points have more deeply concave bases in general and relative to their basal widths. This raises the questions: is biface production a standard, shared process or is there also variation in the Clovis production process?

Biface Technology

The total of 463 preforms, bifaces, and biface fragments from the three sites was analyzed using pair-wise comparisons to evaluate mean sizes and shapes and chi-square tests to compare descriptive characteristics. The successive stages of reduction simply serve as classifications for evaluating bifaces in the process of reduction. For each stage of reduction (examples are shown in Figures 39-41), I compare the characteristics and conditions of the bifaces from the three sites to identify similarities and differences in biface forms and the technological strategies employed in the process.

Early-Stage Bifaces. In terms of general size and shape averages, there are significant differences in early-stage biface assemblages (Table 14). Topper bifaces are the longest and significantly longer than Carson-Conn-Short ($p = 0.029$) and Williamson ($p < 0.000$), and Carson-Conn-Short bifaces are significantly longer than Williamson bifaces ($p = 0.002$). Bifaces from Williamson are the narrowest and significantly narrower than Carson-Conn-Short ($p < 0.000$) and Topper ($p < 0.00$). Carson-Conn-Short and Topper

Table 14. Early-Stage Biface Comparison.

Staging-Area Early-Stage Bifaces Measurements (Averages in mm)	Carson-Conn-Short (n = 31)	Topper (n = 17)	Williamson (n = 38)
Length	98.61	111.04	82.98
Width	62.94	64.78	48.33
Thickness	23.96	26.49	20.11
Length: Width	1.57	1.57	1.73
Width: Thickness	2.78	2.74	2.63
Length: Thickness	3.82	3.50	4.42
Dominant End Thin Length	34.36	15.43	23.22
End Thin Width	9.42	4.22	4.39

bifaces do not differ in width. Williamson early-stage bifaces are also significantly thinner than both Carson-Conn-Short and Topper (*p* = 0.006, *p* = 0.013, respectively). Again, Carson-Conn-Short and Topper are similar in biface thickness.

When the shape ratio of width-to-thickness is compared, bifaces from the three sites are generally similar. However, based on the ratio of length-to-width, Carson-Conn-Short and Topper bifaces are similar, but Williamson bifaces are proportionately longer relative to width than the others (WM vs. CCS, *p* = 0.005; WM vs. TP, *p* = 0.031). In terms of length-to-thickness, Williamson bifaces are longer than they are thick, but only significantly so when compared to thick Topper bifaces (*p* = 0.021). Early-stage bifaces also vary by thinning scar size. Carson-Conn-Short bifaces have significantly longer early-stage end thins when compared to Topper (dominant end-thin length: CCS vs. TP, *p* = 0.001). Carson-Conn-Short also has longer end-thin removals than Williamson but not significantly so (*p* = 0.054).

Early-stage bifaces are also significantly different based on the amount of cortex present (*p* = 0.027), planview shape (*p* < 0.000), base shape (*p* = 0.045), edge shape (*p* = 0.021), and transverse cross-section (*p* = 0.005) (Table 15). Compared to Carson-Conn-Short and Topper bifaces, the Williamson assemblage generally has less than expected bifaces with cortex on both faces and more than expected bifaces with cortex only remaining on one tool face. The Williamson biface assemblage also contains more than expected bifaces with lanceolate-shaped planviews in the initial stage of reduction (as opposed to ovoid or circular forms), and significantly more bifaces with slightly rounded base shapes. Based on edge shape, early-stage bifaces from Carson-Conn-Short have more than expected bifaces with straight-sided edges and less than expected bifaces with convex edges. In addition, Carson-Conn-Short bifaces are comparatively different based on transverse cross-section; there are less than expected bifaces with bi-convex cross-sections and more bi-plano cross-sections.

Table 15. Frequencies of Bifaces with Descriptive Characteristics by Stage of Reduction.

Staging-Area	Carson-Conn-Short	Topper	Williamson	*p*
		Extent of Cortex		
Early Stage				0.027
None	21	24	20	
Present Both Faces	17	11	4	
Present One Face	13	11	20	
Middle Stage				0.438
None	44	54	85	
Present Both Faces	1	3	3	
Present One Face	2	0	5	
Late Stage				0.083
None	23	27	27	
Present Both Faces	1	0	0	
Present One Face	0	5	1	
		Planview Shape		
Early Stage				0.000
Circular	1	1	7	
Lanceolate	2	6	15	
Ovoid	49	35	22	
Straight	0	0	0	
Triangular	0	1	0	
Middle Stage				0.003
Circular	0	0	0	
Lanceolate	35	38	85	
Ovoid	12	14	7	
Straight	0	0	0	

Table 15. Continued.

Staging-Area	Carson-Conn-Short	Topper	Williamson	*p*
Planview Shape				
Triangular	0	0	0	
Late Stage				0.403
Circular	0	0	0	
Lanceolate	20	31	25	
Ovoid	1	1	0	
Straight	1	0	0	
Triangular	1	0	0	
Base Shape				
Early Stage				0.045
Concave	0	3	0	
Ovoid	0	1	0	
Rounded	33	27	34	
Square	18	9	8	
Middle Stage				0.176
Concave	4	2	11	
Ovoid	0	0	0	
Rounded	14	16	19	
Square	22	22	59	
Late Stage				0.044
Concave	2	0	7	
Ovoid	0	0	0	
Rounded	2	2	0	
Square	15	17	16	
Edge Shape				
Early Stage				0.021

Table 15. Continued.

Staging-Area	Carson-Conn-Short	Topper	Williamson	*p*
		Edge Shape		
Convex	35	34	40	
Recurvate	0	2	1	
Straight	17	7	3	
Other	0	1	0	
Middle Stage				0.006
Convex	32	48	61	
Recurvate	0	3	8	
Straight	15	4	24	
Other	0	0	0	
Late Stage				0.000
Convex	11	27	10	
Recurvate	0	0	9	
Straight	13	5	9	
Other	0	0	0	
		Transverse Cross-section		
Early Stage				0.005
Bi-Convex	22	32	29	
Bi-Plano	15	8	2	
Plano-Convex	15	6	13	
Middle Stage				0.142
Bi-Convex	28	45	62	
Bi-Plano	2	1	8	
Plano-Convex	16	11	23	
Late Stage				0.602
Bi-Convex	14	24	17	
Bi-Plano	2	1	1	
Plano-convex	8	7	10	

Beyond aspects of initial shape, bifaces from the three procurement-related sites differ in the type and frequency of thinning removals (Table 16). There are significant differences in the frequency of overface ($p = 0.05$) and end-thin removals ($p = 0.033$). The frequency of overshot flaking is generally low and similar among all the sites. However, compared to Carson-Conn-Short and Williamson, Topper has more early-stage bifaces without overface removals. Further, Topper also has significantly fewer bifaces with end-thin removals. Both Carson-Conn-Short and Williamson have overfacing and end-thinning features in similar high frequencies.

Middle-Stage Bifaces and Early-to-Middle-Stage Reduction. By the middle stage of reduction, size relationships between bifaces from the three sites are more similar relative to early-stage comparisons (Table 17). Biface length is no longer a significant factor differentiating the assemblages. At this point in the reduction process, Williamson biface widths are still significantly narrower than the other sites (WM vs. CCS, $p < 0.000$; WM vs. TP, $p < 0.000$). Williamson middle-stage bifaces continue to be the significantly thinnest (WM vs. CCS, $p < 0.000$; WM vs. TP, $p < 0.000$). By the middle-stage of reduction, Carson-Conn-Short and Topper bifaces are still similar in average width and thickness.

Table 16. Frequencies of Bifaces with Thinning Removals by Stage of Reduction.

Staging-Area	Carson-Conn-Short	Topper	Williamson	*p*
Overshots				
Early Stage				0.541
0	44	34	40	
1	6	7	2	
2+	2	3	2	
Middle Stage				0.131
0	41	49	89	
1	5	8	3	
2+	0	0	1	
Late Stage				0.034
0	23	23	27	
1	1	8	1	
2+	0	1	0	
Overfaces				
Early Stage				0.05
0	12	21	11	
1	12	13	6	
2+	28	10	16	
Middle Stage				0.384
0	8	11	25	
1	11	13	30	
2+	27	33	38	
Late Stage				0.036
0	6	7	9	
1	7	4	6	
2+	11	21	13	
End Thins				
Early Stage				0.033
0	19	29	16	
1	15	6	19	
2+	18	11	9	
Middle Stage				0.001
0	9	30	20	
1	14	16	24	
2+	24	11	50	
Late Stage				0.12
0	4	17	4	
1	6	5	7	
2+	14	11	17	

All the assemblages share a common middle-stage shape in terms of width-to-thickness and length-to-thickness (Table 17). Williamson points, however, vary by length-to-width and continue to be comparatively longer relative to width (WM vs. CCS, *p* = 0.016; WM vs. TP, *p* = 0.009). Carson-Conn-Short and Topper middle-stage bifaces share a common shape based on all shape ratios.

Table 17. Middle Stage Biface Comparisons.

Staging-Area	Carson-Conn-Short	Topper	Williamson
Middle Stage Bifaces Measurements (averages in mm)	(n = 47)	(n = 57)	(n = 94)
Length	76.36	69.49	67.16
Width	45.99	46.86	35.47
Thickness	12.04	35.47	10.24
Length: Width	1.72	1.59	2.06
Width: Thickness	3.91	3.80	3.55
Length: Thickness	6.11	5.29	5.81
Dominant End Thin Length	29.90	15.35	20.44
End Thin Width	7.41	4.09	5.02

End-thinning length continues to be a factor that differentiates the assemblages (Table 17). Carson-Conn-Short bifaces still have the longest end-thin removals, with an average that is significantly longer than Topper (*p* < 0.000) and Williamson bifaces (*p* = 0.003). Topper has the shortest average end-thin length. Likewise, Williamson bifaces also have relatively long removals, with an average that is significantly longer than Topper biface end-thins ($p = 0.020$). In terms of descriptive characteristics, middle-stage bifaces from the three sites are also more alike (Table 15). Unlike early reduction, the extent of cortex, transverse cross-section, and base shape are no longer factors distinguishing assemblages. Other characteristics, however, continue to differentiate, with the Williamson assemblage having more than expected lanceolate forms and less than expected ovoid forms ($p = 0.003$). By the middle stage of reduction the Topper form outline changes to bifaces with convex edge shapes and less straight-sided forms ($p = 0.006$).

Aspects of thinning removals also change by the middle stage of reduction (Table 16). The frequency of overshot flaking remains insignificant but now overface removals are no longer significantly different; all assemblages have evidence of this thinning strategy. In terms of end thinning, Topper knappers still did not use this thinning technique as frequently as at the other quarry-related sites ($p = 0.001$).

Thus, by the end of the early and middle stages of reduction at each site, some biface idiosyncracies potentially related to raw-material-outcrop conditions had been corrected for in production. The extent of cortex, transverse cross-section, length, and shape measures (e.g., width-to-thickness and length-to-thickness) no longer distinguish the three site assemblages. Patterns of the extent of width and thickness reduction are also relatively similar (Table 18). Based on the percentage of biface width lost from early to middle stages of reduction, Carson-Conn-Short bifaces are reduced by 26.9%, Topper bifaces are reduced by 27.7%, and Williamson bifaces are reduced by 26.6%

(Figure 47). The reduction of biface thickness follows the same pattern but to a greater degree, suggesting thinning was a major priority in the earliest stages of reduction. Carson-Conn-Short bifaces are reduced by 49.75%, Topper bifaces are reduced by 52.66%, and Williamson bifaces are reduced by 49.08% (Figure 48). Topper knappers

Table 18. Tempo of Reduction Based on the Percentage of Width and Thickness Lost in Reduction by Stage of Production.

Staging Areas	Carson-Conn-Short		Topper		Williamson	
	% Width	Tempo	% Width	Tempo	% Width	Tempo
Early to Middle	26.93%	Fast	27.66%	Fast	26.61%	Fast
Middle to Late	13.2%	Slow	17.61%	Medium	19.9%	Medium
Late to Finished Point	26.3%	Fast	30.77%	Fast	12.74%	Slow
	% Thickness	Tempo	% Thickness	Tempo	% Thickness	Tempo
Early to Middle	49.75%	Fast	52.66%	Fast	49.08%	Fast
Middle to Late	16.69%	Slow	23.29%	Medium	23.63%	Medium
Late to Finished Point	30.31%	Fast	26.09%	Medium	10.10%	Slow

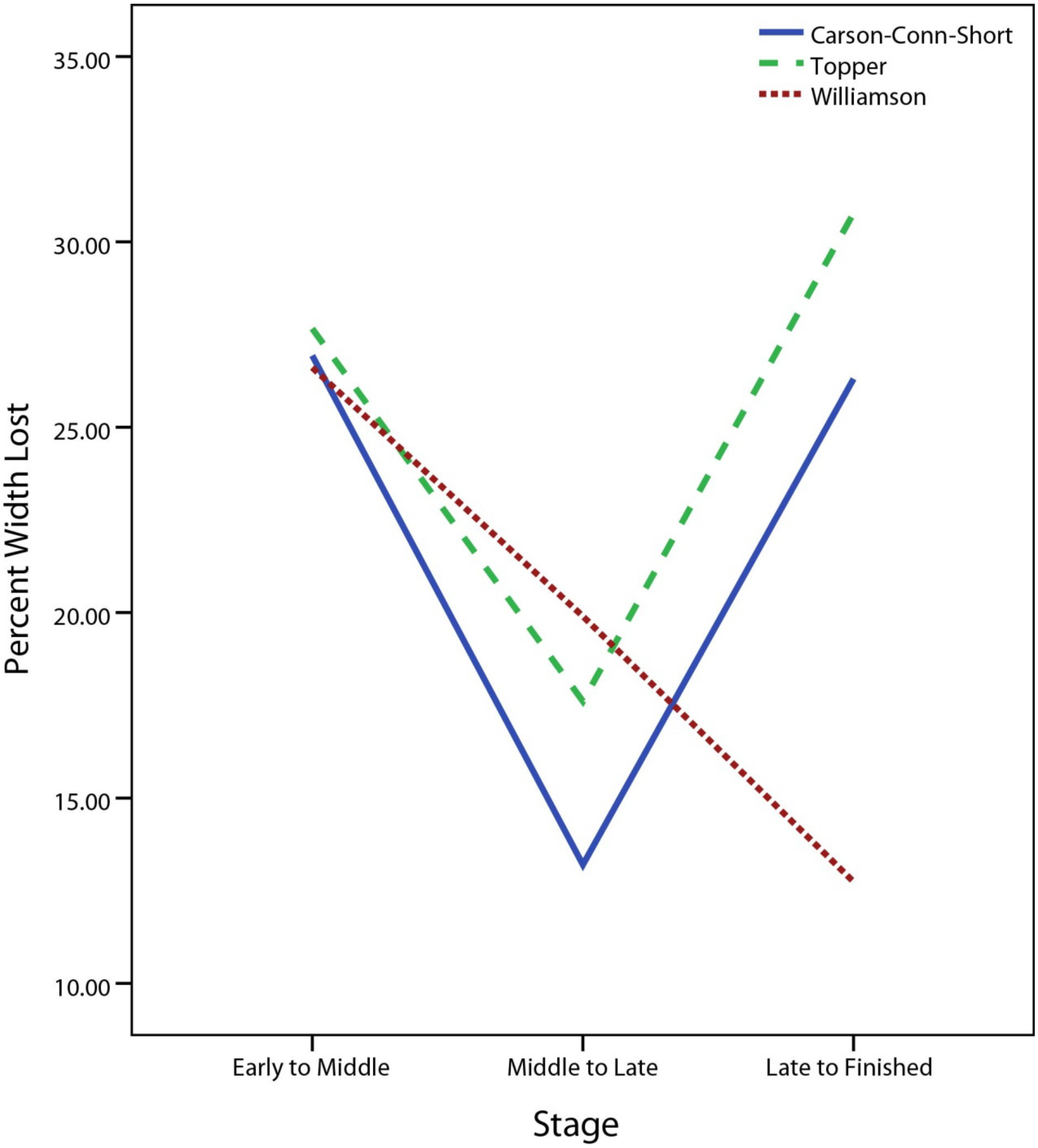


Figure 47. Lines comparing the tempos of width reduction (or width lost) through the biface production process at the three main study sites.

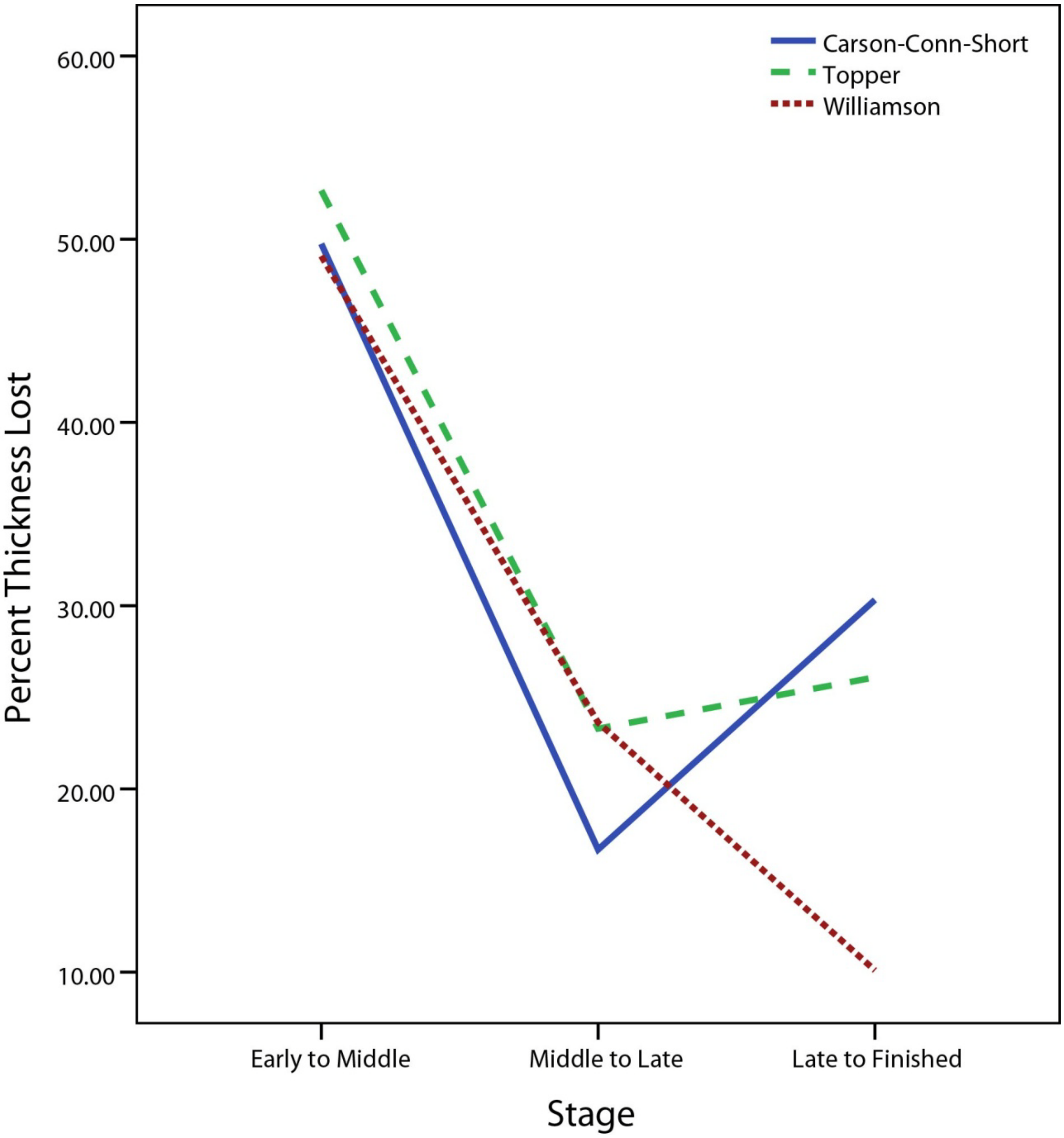


Figure 48. Lines comparing the tempos of thickness reduction (or thickness lost) through the biface production process at the three main study sites.

thinned bifaces to a slightly greater extent, but generally from early to middle stage all three site-average biface forms were reduced with a standard proportion lost. However, the Topper bifaces are still significantly thicker, a characteristic that may be raw-material driven or could be a deliberate difference in reduction strategies.

Late-Stage Bifaces and Middle-to-Late-Stage Reduction. Bifaces in the late stage of reduction are distinguished by size but less variable by shape (Table 19). In terms of size, Williamson bifaces are significantly narrower and thinner than the other two biface forms (width: WM vs. CCS, $p < 0.000$; WM vs. TP, $p < 0.000$; thickness: WM vs. CCS, $p = 0.004$; WM vs. TP, $p = 0.008$).

Based on shape ratios, late-stage bifaces from the three sites are similar in terms of length-to-thickness and shape based on length-to-width (Table 19). At this stage of reduction, the width-to-thickness ratio, a ratio not differentiating the sites in the early and middle stages, is now significantly different ($p = 0.017$). Carson-Conn-Short and Topper are similar based on this shape ratio, but Williamson is significantly narrower relative to thickness (WM vs. CCS, $p = 0.014$; WM vs. TP, $p = 0.014$).

By the late stage of reduction, length and width measurements of end-thinning removals are similar among Carson-Conn-Short and Williamson bifaces (Table 19). However, Carson-Conn-Short end-thin lengths are slightly significantly longer than Topper ($p = 0.046$), while Williamson bifaces also have significantly longer end thins than Topper ($p = 0.010$).

Table 19. Late Stage Biface Comparisons.

Staging-Area Late Stage Bifaces Measurements (Averages in mm)	Carson-Conn-Short (n = 24)	Topper (n = 33)	Williamson (n = 28)
Length	61.72	70.17	53.23
Width	39.92	38.61	28.41
Thickness	10.03	9.62	7.82
Length: Width	1.86	1.85	1.97
Width: Thickness	4.15	4.11	3.68
Length: Thickness	22.67	8.21	15.99
Dominant End Thin Length	26.20	10.83	19.02
End Thin Width	5.09	5.81	4.81

By the late stage, some descriptive characteristics remain similar while others become more prominent features for differentiating the biface assemblages (Table 15). The extent of cortex and cross-section shape still do not vary significantly, and planview shapes are more standard, too, mostly lanceolate-shaped. However, the Carson-Conn-Short assemblage has significantly more bifaces with straight-sided lateral margins, Topper has significantly more bifaces with convex margins, and Williamson has significantly more bifaces with excurvate margins ($p < 0.000$). Williamson late-stage bifaces are also significantly more concave-based than bifaces in the other assemblages ($p = 0.044$).

In terms of the type and frequency of biface thinning removals, late-stage Topper bifaces have significantly more overshot and overface scars ($p = 0.034$ and $p = 0.036$, respectively), but the use of end thinning does not vary and is significantly used to greater degrees than earlier in the reduction process at all three sites (Table 16).

At the transition from middle to late stages, bifaces are comparable in length, but Williamson bifaces are significantly smaller in width and thickness. In terms of shape, width-to-thickness, a consistently shared shape in early and middle-stages of reduction, diverges. For the first time, the average Williamson biface is significantly narrower relative to thickness. Biface shapes remain similar in length-to-thickness; and at this transition, differences of length-to-width are standardized and no longer differentiate the assemblages. By the transition from the middle-to-late stages, all biface shapes have been corrected. In other words, during the reduction process, from the early-to-late stages, at some point in production each shape ratio became a non-significant factor. By the late stage, bifaces from all three sites have shared commonalities in shapes. Other characteristics that could be raw-material driven, like extent of cortex and transverse cross-section, are also not significant factors after the early stage and remain so through the late stage. The most notable changes at the production transition occur in edge shape and thinning strategies. Based on edge shape, the three assemblages are distinguished by the predominance of unique forms—straight-sided bifaces, convex-sided bifaces, and recurvate-sided bifaces (i.e., biface edge shapes are convex at the blade, curve back inward at the haft element, and widen again at the base). Thinning strategies suggest that important technological differences are present. For the first time in the reduction process, Topper knappers focused on thinning as a major production goal, and they began to use overshot and overface flaking more frequently than seen at the other two sites. Interestingly, unlike the previous early-to-middle-stage transition, patterns of width and thickness reduction are not as standard among the assemblages (Table 18). Based on percentage of biface width lost, less material was removed with the middle-to-late-stage transition. Carson-Conn-Short bifaces are reduced only by 13.2%, Topper bifaces are reduced by 17.6%, and Williamson bifaces are reduced by 19.9% (Figure 47). The reduction of biface thickness follows a similar pattern; Carson-Conn-Short bifaces are reduced by 16.7%, Topper bifaces are reduced by 23.3%, and Williamson bifaces are reduced by 23.6% (Figure 48). Therefore, at this point in production, Williamson bifaces were reduced the most by width and thickness, but there is a general decreasing trend in the extent of reduction for all three assemblages.

Finished Points and Late-Stage to Finished Points. As noted above, on average, finished fluted points differ in terms of size and shape. Points from the Carson-Conn-Short area are significantly larger in length and width and more robust in shape, while finished points from the Williamson region are the shortest and narrowest with the least robust shapes. Topper falls between the two (Table 12). These characteristics are unexpected because late-stage bifaces are not significantly different in length and shapes ratios of length-to-width or length-to-thickness. Further, Carson-Conn-Short points are distinguished by unique basal features; the point bases are significantly more concave and have deeper basal concavities in proportion to basal widths. Williamson points are widest at the base in comparison to the blade or body width.

In the transition from late-stage biface to finished point, significant differences in technology are apparent. The extent of width and thickness reduction notably varies from the pattern in the previous transition (Table 16). Instead of a continued decrease in the percentage lost with width reduction (Figure 47), Carson-Conn-Short (26.3% width loss) and Topper (30.8% width loss) knappers actually used thinning nearly twice as much as they did in the middle-to-late-stage-production transition. Williamson knappers, however, decreased the extent of width reduction and removed less material than previously (only 12.7% of width is lost). Reduction patterns for thickness are also unexpected (Figure 48). Carson-Conn-Short bifaces are reduced in thickness significantly more (30.3% thickness loss); they are thinned nearly twice as much as they were in the middle-to-late-reduction process. Topper knappers also increased the extent of reduction (26.1% thickness loss) but not to the same degree as Carson-Conn-Short. Finally, based on previous reduction patterns, Williamson bifaces follow the expected trend, and the percentage of biface thinning decreases from the late stage to final stage of point production (only 10.1% of thickness is lost). Thus, through evaluating the extent of width and thickness reduction as a process, three different reduction patterns have emerged. Each assemblage has a unique pattern in the timing and pace, or *tempo*, for narrowing and thinning the biface form.

The overall width and thickness lost in production from early stage to finished point for each site followed a similar pattern (Table 16). In terms of width, Topper bifaces are reduced the most from the early-stage state (58.7%), Carson-Conn-Short reduce slightly less than Topper (53.3%), and Williamson knappers reduced width least relative to early stage width (48.7%) (Figure 47). Based on thickness reduction patterns, Topper also reduced thickness to the greatest extent (73.2%), Carson-Conn-Short thinned less (70.8%), and again, Williamson thinned thickness the least (65.0%) (Figure 48).

Discussion

This study evaluates Anderson's staging-area model for Clovis settlement in the Southeast in light of competing high-technology/high-mobility models (e.g., Kelly and Todd 1988). With the use of finished point data from the three subregions, coupled with site-level biface data from the three procurement-related sites, the discussion that follows first addresses the role raw material played in determining biface forms, and second, recognizes aspects of technology and point morphology that characterize Clovis in the Southeast. The final part of the discussion addresses the two cultural inferences derived for the HTF and staging-area models. First, if rapidly moving Clovis groups shifted ranges frequently and inhabited locations for short durations, as described in the HTF model, I expect a lack of regional variation in Clovis points and bifacial technology from the subregions. However, if the Carson-Conn-Short, Topper, and Williamson areas represent more discrete population concentrations settled for relatively longer periods, as predicted by the staging-area model, I expect morphological variation between Clovis points and distinct manufacturing signatures, or techniques that differentiate bifacial tool technologies represented at each site.

The Role of Raw Material in Biface and Point Production

While there are differences in toolstone conditions at the three sites, analysis of reduction sequences shows that initial material characteristics did not directly determine final point shape by the middle stage of reduction. The effects of toolstone did not distinguish the three assemblages in terms of the extent of cortex or blank cross-section shape. Through reduction, potential raw-material shape limitations were also overcome. Early-stage bifaces from Carson-Conn-Short and Topper share a common shape, and in spite of inherent differences between the tabular Fort Payne chert at Carson-Conn-Short and nodular Coastal Plain chert at Topper, knappers from both procurement sites produced similar biface shapes early in production. Width-to-thickness at Williamson was also not affected by raw material conditions, but the Little Cattail Creek chalcedony outcrop at Williamson may have contributed to greater variation early in reduction. Initially, shape ratios of length-to-width and length-to-thickness significantly differed between Williamson and the other sites. However, by the middle stage of reduction, these shape ratios were no longer significantly different, again demonstrating that toolstone variability did not directly affect final point shape. Therefore, distinctions in point design were the intentional products of reduction techniques and strategies.

Shared Aspects of Clovis Technology and Point Morphology in the Southeast

Based on biface and point data from the three Southeast subregions, there are standard aspects of the Clovis lithic reduction sequence that are shared regionally. Early-stage bifaces are relatively similar in shape, and overshot and overface flaking as well as end thinning were shared strategies used early in production. By the middle stage of production, Clovis bifaces were similar in length, and shape limitations of raw-material outcrop conditions (e.g., width-to-thickness and length-to-width) were overcome in the reduction process. Overface and overshot flaking techniques continued to be used regularly as thinning strategies, and end thinning was also employed but the extent of its use varied among sites. Bifaces in the late stage of production were lanceolate in form and had shared proportional shape ratios. Finished Clovis points from the three subregions are all similar in thickness; this was a significant aspect of shared Clovis point design. The points have end-thinning flake scars, or final flute scars, characteristic of “classic” Clovis technology, and accordingly, the ratios of flute length to maximum point length are about 40% for all three subregions.

Is There Morphological Variation between Clovis Points from the Three Subregions?

There is morphological variation between Clovis points from the Carson-Conn-Short, Topper, and Williamson subregions. Carson-Conn-Short points are generally the most robust in length, width, and basal width, and this pattern is not only evident in terms of size, but continues with ratios of shape. Carson-Conn-Short points are disproportionately narrow relative to their blade length, while Williamson points represent the opposite size extreme, an outcome that at first seems predictable based on raw-material package size, but Williamson points have relatively wider basal widths relative to body widths, suggesting their shape was stylistic or the product of unique resharpening behavior. Perhaps Williamson points were left in the haft longer, leading to more resharpening episodes and significantly larger base-to-blade width proportions. Either way, if Clovis point production varied, it follows that unique regional patterns of variation should also be expected throughout a point's life history with the continued process of use, resharpening, and rework (Bever and Meltzer 2007). Other attributes of the base demonstrate that there are fine distinctions caused from variation in the design of the haft element. The depth of basal concavity significantly distinguishes finished points from the three subregions, with Carson-Conn-Short points being the most concave. Moreover, average flute length on Carson-Conn-Short points is less than half the maximum point length, indicating more deeply concave bases are not associated with full-face fluting, a trait suggested to characterize presumed later point styles in the region (e.g., Redstone) (Daniel and Goodyear 2006; Goodyear 2006). Finally, based on size and most shape attributes, Topper area points generally fall between Carson-Conn-Short and Williamson area points.

These differences in point morphology become even more interesting when the degree of variation within each subregion is evaluated (Table 13). Attributes involving depth of basal concavity are the most variable relative to other factors for all staging-area samples. In a similar study of late Paleoindian point variability, Taylor-Montoya (2007) also found that basal concavity produced the highest coefficient of variation (see also Bever and Meltzer 2007), and after eliminating factors of unpatterned modification, he concluded that the dimensions of basal concavity may be due to stylistic factors in haft construction. Thus, the high variation of basal morphology measured in the present study could be a product of individual stylistic variation among knappers in each potential staging area, and based on significant differences in mean basal attribute measures, this stylistic variation produced meaningful spatial patterns to distinguish the Carson-Conn-Short, Topper, and Williamson subregions.

Are There Distinct Manufacturing Signatures, or Techniques That Differentiate Regional Bifacial Technologies?

Preferences for Thinning Techniques. One of the most significant factors differentiating reduction sequences is the type of thinning strategy preferred at each site. At Carson-Conn-Short, knappers used overshot and overface flaking but relied on end thinning as the predominant thinning strategy early on and throughout the production process. End thin removals were key to reduction; they were significantly long and wide in the early and middle stages. These long and wide end thins removed material along the longitudinal axis and tabular edges. Contrary to this, Topper bifaces were thinned using overface and overshot flaking. Topper knappers used end thinning significantly less in the early and middle stages of production. Further, it is not until the late stage that thinning with broad removals became a major production objective, and overfacing and overshotting appear to be the preferred reduction strategies. Williamson knappers used both thinning strategies. Early-stage bifaces from the site have evidence of overface and end thinning, but overface flaking was used to a greater degree. By the late stage, Williamson bifaces were predominately reduced with end-thin removals, and these removals were relatively similar in length to average scars found on Carson-Conn-Short bifaces. This variation in techniques suggests that the decision-making process of reduction was not based on a standard, patterned series of removals, but by thinning preferences specific to each site.

Distinctions in the Tempo of Reduction. Not only are there divergences in preferred thinning strategies, but there are also distinct manufacturing signatures based on the timing and pace of thinning, referred to here as the tempo of reduction (Table 7, Figures 10 and 11). When the entire range of biface manufacture is evaluated, each site appears to have a unique signature for the tempo of production. Carson-Conn-Short knappers focused reduction strategies to thin bifaces most early in the reduction process, and as mentioned above, end thinning was the primary technique used to reduce biface width and thickness. The extent of width reduction decreases twofold from middle to late stages, but increases equally again with finished point forms. Therefore, Carson-Conn-Short knappers thinned and narrowed quickly while maintaining length. They focused least on width and thickness reduction midway through the process, instead shaping biface edge shape and planview. And, finally, Carson-Conn-Short knappers thinned again while uniquely shaping basal elements with deep concavities in the final stages of production. The Carson-Conn-Short reduction tempo follows a fast-slow-fast reduction pattern for both width and thickness, producing a point significantly different in robustness compared to the other sites.

The tempo of biface production at Topper is slightly different from the tempo at Carson-Conn-Short and produces a different morphological outcome, possibly because Topper knappers predominantly relied on overface and overshot thinning. Topper knappers started with wide and thick early-stage bifaces. The extent of width and thickness reduction from the early-to-middle stages is the highest at Topper relative to the other sites, and based on the presence of thinning removals, Topper knappers began the thinning process with overshot and overface flaking in the middle stage of reduction. From the middle to late stages of production, the extent of width and thickness reduction slightly decreases but not nearly as much as seen at Carson-Conn-Short. Then, from the late to finished point stages, Topper knappers shaped excurvate lateral margins and dramatically increased efforts to narrow the biface, a pattern consistent with a significant increase in overfacing and overshotting. However, at this point in reduction, width was reduced more than thickness. Because Topper knappers thinned more during the first two stages, they managed to craft finished points similar to the average thicknesses of points from the other regions. Thus, Topper biface widths were reduced by a fast-medium-fast tempo, while biface thicknesses were reduced by a fast-medium-medium tempo of reduction.

The tempo of reduction at Williamson follows a notably distinct pattern compared to Carson-Conn-Short and Topper. At Williamson, the extent of width and thickness reduction in the early stage is similar to reduction at the other sites. Further, early reduction strategies are also consistent. Williamson knappers, like Carson-Conn-Short knappers, used end thinning as the main technique early in reduction; however, Williamson knappers consistently produced significantly shorter end thins. Consistency in the early stage gave way to a distinct manufacturing sequence in later stages. In the middle stage of production, Williamson bifaces were already shaped as lanceolates; at the other sites bifaces did not take this form until the late stage. Additionally, while Carson-Conn-Short and Williamson bifaces were both reduced by predominantly using end thinning, they were not narrowed and thinned at the same tempo. At the middle stage, Williamson bifaces were the same size as Carson-Conn-Short bifaces, but Williamson knappers reduced biface width and thickness approximately 1.5 times more than Carson-Conn-Short during the middle-late transition. In fact, at this production transition, they also narrowed and thinned relatively more than at the Topper site. The late-to-finished reduction pattern is also distinct. Although Williamson and Topper knappers seem to have a similar intended final goal (finished points are similar in length, width, and thickness), Williamson knappers reduced width and thickness markedly less than Carson-Conn-Short and Topper knappers. Therefore, Williamson biface widths and thicknesses were achieved through a unique fast-medium-slow reduction tempo.

Evaluating Dispersal Models

The lack of homogeneity in point morphology and biface manufacturing sequences presented here is at odds with rapid-mobility models of Clovis settlement (e.g., Kelly and Todd 1988). The staging-area model of Clovis settlement (Anderson 1996) implies two key cultural expectations—points should stylistically vary in morphology, and biface production should have subregionally distinct manufacturing signatures. Based on the analyses presented here, both of these expectations are met. In the Clovis point template, there are nuances of variation in point shape and design. Further, while there were differences in raw-material conditions that may have initially impacted early-stage biface production, these differences were quickly corrected by the middle stage of production. In the point production process, Clovis knappers at each procurement-related site used diagnostic Clovis techniques, but the preferred thinning strategy and tempo of reduction varied. The variation identified in this study constitutes the first technologically-based evidence in support of the staging-area model.

Anderson's (1990, 1996) model also predicts colonization routes or directionality in the settlement process based on varied distributions of Clovis projectile points, and therefore, assumes potential differences in site chronologies. While assessments of the timing of occupations, and worse even the timing of colonization of the Southeast, are handicapped by the lack of radiocarbon dates, the directionality implied in Anderson's model can be considered in terms of inter-site comparisons and in light of some previous hypotheses of temporal differences based on stylistic distinctions. Because of the high density of point concentrations and positioning near a major river valley, the model predicts the Carson-Conn-Short subregion was an initial population concentration. Based on comparable but less extensive point concentrations and Topper's positioning at the southern-most extent of the Atlantic Coastal Plain, this region was a secondary population concentration, settled after Carson-Conn-Short (Anderson 1990). Accordingly, Williamson was also a later population concentration, presumably settled after the Topper area as fissioned Clovis populations dispersed northward along the Coastal Plain. Therefore, if Anderson's predictions for timing and directionality are correct, then morphology and production at Carson-Conn-Short should represent early Clovis technology in the region, and these factors should be most similar to characteristics at Topper. Finally, style and technology represented at Williamson should have been influenced directly by behaviors at Topper, and only indirectly by behaviors at Carson-Conn-Short.

With this is mind, based on the size and shape of finished points, Carson-Conn-Short and Williamson represent the opposite extremes of patterns, making Topper the intermediate form. This is a relationship consistent with the directionality implied in the model. Further, when it comes to biface-to-point production, not just final form, Carson-Conn-Short and Williamson knappers reduced bifaces based on distinctly different tempos of reduction, but interestingly shared preferred thinning strategies. Variance in the tempo of reduction suggests that the two groups had a shared knowledge of end thinning and had similar goals in tool production, but the decision-making process of reduction differed. In terms of tempo, the timing and pace of reduction at Topper falls between the other areas. Perhaps, as Clovis groups settled into increasingly disparate subregions, there was a restructuring in the process of Clovis biface production that created differences in procedural aspects while maintaining strong affinities to the original Clovis template. Based on these technological trends, this restructuring could have occurred in accordance with the directionality of Anderson’s settlement model.

However, morphological characteristics of the basal elements of points obfuscate this relationship and obscure patterns of directionality and timing. Fluted forms with distinctly concave bases have been found at sites that post-date the Clovis period (MacDonald 1968), leading some researchers to suggest an increase in basal concavity was associated with a technological shift marking the cultural transition from the early to middle Paleoindian periods (Daniel and Goodyear 2006; Goodyear 2006). If this hypothesis is correct and Clovis points in the region gradually gave way to more concave-based points, then Carson-Conn-Short area Clovis points, with the deepest average basal concavity and highest ratio of basal concavity to basal width, may in fact be later Clovis forms. The trend of less concave to more concave is reversed from the predicted Carson-Conn-Short to Topper to Williamson direction of settlement, and the predicted initial population concentration is the morphological outlier. Thus, when concavity is considered in terms of size and point shape, the trend does not follow and is not parsimonious with the directionality implied in the staging-area model. As an alternative, this morphological variation could be the cumulative effect of variation over time. As Anderson’s model predicts, Carson-Conn-Short was the first staging area inhabited in the Southeast, and thus, Clovis people occupied this area for the longest period of time. The long site history at Carson-Conn-Short could have led to incremental innovations in the design of the hafting element, and this may explain the high degree of basal variation among Clovis points from the area. Further, based on the ratio of depth-of-concavity-to-basal-width, Carson-Conn-Short also clusters with the regional average—a trend consistent with the model prediction that Carson-Conn-Short was an initial population concentration. One aspect of technology also obscures patterns of directionality. Topper knappers end thinned bifaces significantly less often than both Carson-Conn-Short and Williamson knappers, and instead overshotting and overfacing were key in late-stage thinning. In terms of preferred reduction techniques, Topper is the regional outlier.

Unfortunately, considerations of the staging-area model's predictions for the timing of Clovis settlement and directionality of subsequent population fissioning into separate subregions admittedly fall short without reliable radiocarbon dates from the region. Now that significant technological differences have been identified suggesting separate population concentrations, further analysis of the directionality of raw materials and organization of entire tool assemblages are needed to fully understand the timing and process of Clovis settlement in the Southeast.

What about Cultural Transmission of Clovis Technology across a Pre-existing Population?

An obvious problem with the staging-area model is that of equifinality—its testable implications may not be easily distinguished from those of a Clovis diffusion model. Twenty years ago, Willig (1991:92) suggested that the "pan-continental pattern" of Clovis tool kits and fluted point forms could be due to the spread of a technology that was regionally adapted by pre-existing groups of people in unique microenvironments. Could such a model explain the Clovis record in the Southeast? Certainly, pre-Clovis sites have been proposed for this region (e.g., Topper, Page-Ladson, and Cactus Hill) (Bradley and Stanford 2006; Dunbar 2006; Goodyear 2005a; McAvoy and McAvoy 1997), so it behooves us to consider an alternative explanation.

The evidence for variation in point morphology among the three assemblages analyzed in this study could be the result of the spread of Clovis point technology through an extant population. Technological distinctions in biface production, like the preferences for thinning strategies and differences in reduction tempos presented here, could also reflect the transmission and regionalization of Clovis technology among contemporary populations.

Cultural transmission theory offers a plausible mechanism for explaining variation in a shared technology. An analogous case may be Bettinger and Eerkins's (1999) investigation of the effects of different modes of cultural transmission in their analysis of the transition from atlatl to bow and arrow in the Great Basin of western

North America. They suggested that variability in point forms may represent differences in the manner in which the technology was culturally transmitted. In other words, distinct cultural groups with variable social systems adopted the bow and arrow differently. In this vein, if Clovis technology was culturally transmitted through an open social system of minimally-interacting extant populations, then point makers could have initially adopted Clovis technology but then independently modified point form and reduction techniques to meet their unique needs. Short of developing a new model that carefully develops and explicitly predicts the archaeological implications of cultural transmission of Clovis technology through pre-existing populations, I cannot rule out the possibility that my results support such an explanation.

Conclusions

The staging-area model predicts Clovis settlement in the American Southeast was a gradual, step-wise process that led to discrete population concentrations of Clovis groups settled into resource-rich locations. These population concentrations or staging areas became the geographic centers and demographic foundations for early cultural regionalization. The analysis presented here applies regional and site-level data to evaluate this model, an essential step toward understanding how Clovis groups organized technologies and settlement in the Southeast. Based on the analysis of point and biface assemblages, the Carson-Conn-Short, Topper, and Williamson regions shared technological traits diagnostic of Clovis; however, there is subregional variation within

Clovis fluted-point form and technology. Each subregion is characterized by subtle distinctions in point morphology and biface production that appear to be culturally-based. Raw-material outcrop conditions did not ultimately affect final point form. The presence of heterogeneity suggests the subregions represent distinct groups who uniquely altered aspects of their technology but maintained basic elements of the Clovis tradition.

CHAPTER V

CONCLUSION

Clovis was initially discovered and defined based on evidence from the Plains and Southwest, and ultimately, these regions have molded our perceptions and interpretations of the nature of Clovis. With recent site discoveries in the Southeast, the scope of our understanding is broadening. Emerging evidence suggests that traditionally-accepted, western-centric models do not fully explain Clovis technological characteristics and settlement patterns in the American Southeast. This dissertation characterizes Clovis technology and settlement in the region. I evaluate some long-standing standards of “classic” Clovis and offer the southeastern perspective.

Prior to the 1990s, when sites like Adams, Carson-Conn-Short, and Topper had not yet been discovered, the Southeast was thought to be only ephemerally explored by Clovis people. With the discovery of large procurement-related sites associated with dense scatters of artifacts this notion has changed. The extent of the Clovis occupation of the Southeast is growing increasingly clearer, and with this, patterns in the occupation history have begun to develop. While the Plains and Southwest are characterized by kill sites, caches, and small camps, the Southeast offers a distinct view of Clovis lifeways. In the Southeast, Clovis people occupied resource-rich areas, where they regularly exploited raw material, produced tools, and conducted a variety of use activities, leaving behind extensive evidence of occupation of large-scale site areas. Sites like these are rare in the West (the only comparable site is Gault, TX). While preservation may explain the lack of kill sites in the East, it does not explain the dearth of procurement-camps in the West. In Chapter II, this dissertation described excavations from Topper, a large procure-related site in the Southeast and the only reported buried, stratified site in the South Atlantic Coastal Plain. Topper provides evidence of a rich Clovis presence. To date, 590 m^2 have been excavated, and the extent of the Clovis occupation is still unknown. In my analysis of a 40 m^2 block, I demonstrated that the Topper hillside contains a buried Clovis assemblage clearly differentiated from overlying Archaic and Woodland occupations. Further, evidence for multiple site activities, on-site manufacture and use of a variety of tools, and the predominance of local raw material suggests that Clovis occupants used the Topper site as a residential base. Topper, with its secure site integrity and extensive Clovis assemblage, offers two important insights: 1) the Clovis occupation of the Southeast is more than lithic scatters and isolated points and, thus, was likely not the product of a transient population, and 2) the pattern in site occupations, with a predominance of large procurement-related residential bases, is distinct from the West and a unique view of Clovis.

Clovis assemblages from the Plains and Southwest are the benchmarks for defining “classic” Clovis technology, but only one Clovis site in the West, Gault, is a primary manufacturing locality. Topper provides a rare glimpse of the entire range of Clovis tool manufacture and the empirical evidence critical to reconstructing how Clovis people organized technology. In Chapter III, my analysis of the biface assemblage shows the nature of Clovis lithic procurement and tool production varied from some long-standing standards defined in the West. I reconstructed the process of Clovis biface manufacture to demonstrate that Topper flintknappers did craft bifaces similar to those from other Clovis localities, but they also produced bifaces not so typical of “classic” Clovis. Clovis knappers at Topper used production strategies, like overshot flaking and end thinning, but they adjusted technology to produce bifaces in a variety of sizes and forms. Rather than just manufacturing large maintainable biface cores and finished points, the Topper occupants also produced bifacial tools like adzes, choppers, and knives. Further, Topper knappers produced late-stage preforms with evidence of diagnostic thinning strategies but dimensions that fall in a broader size-range. Many preforms have dimensions comparable to finished, used points. 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 added an element of variability to tool kit design. Archaeological records at procurement sites are critical for understanding how people organized their technology with respect to their degree of mobility. Topper is one of only two known buried, stratified Clovis procurement-related sites in North America (note: reevaluations of Thunderbird, VA, another large procurement-relate site in the Southeast, are currently underway). Thus, the assemblage from Topper is not only important for interpreting technological organization in the Southeast, but it also contributes new and fundamental information about how Clovis people integrated tool systems into their lifeways. The tool production assemblages at Topper offer three important implications for Clovis tool kit design and technological organization: 1) the bifacial forms at Topper, other than point preforms and biface cores, reveal a greater functional diversity in the Clovis bifacial tool kit; 2) Clovis people were technologically flexible and adjusted the bifacial components of their toolkit to local resource conditions, so characterizations of the Clovis complex should not over-generalize standards for tool size but rather focus on the presence and meaning of key aspects of technology; and 3) unlike traditional models of Clovis mobility, evidence at Topper indicates 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.

The HTF model, like other traditional interpretations of mobility, predicts Clovis people were highly-mobile big-game hunters who continually shifted ranges and left behind behaviorally consistent archaeological records, undifferentiated within a region, regardless of the geographic location. Again, these models were primarily based on the western record of kill sites and scattered camps, where admittedly most of the dated Clovis sites are located. The HTF model is still today one of the most widely accepted interpretations of Early Paleoindian mobility. I recognize the HTF model still adequately explains the Clovis record in the Plains and Southwest, though the predominance of large multiple-task localities in the southern Plains is a bit perplexing. And, I by no means mean to single out the HTF model, which is, indeed, one of the most thorough and eloquently-devised models in Paleoindian research. However, I do find that it just doesn’t quite fit the record in the Southeast. Settlement in this region may be a unique view of the Clovis record, but it is still a substantial view of that process. In Chapter IV, I analyzed southeastern Clovis point data and biface assemblages from Carson-Conn-Short, Topper, and Williamson to test the technological implications of the HTF and

Staging-Area models. The staging-area model predicts that Clovis settlement was more gradual than predicted by the HTF model. Clovis groups entered the continent and slowed migration to concentrate territorial ranges around resource-rich river valleys. These staging-areas became the demographic foundations for early cultural regionalization. This settlement process would produce heterogeneity between the point and biface assemblages from the sites within the region. My analysis demonstrated evidence for variation in point morphology, like differences in point shapes and basal elements, and technological distinctions in biface production, like the preferences for thinning strategies and differences in reduction tempos. Ultimately, the patterns I found are not consistent with the high-technology/high-mobility model, but do fit the staging-area model. My analysis of the *chaînes opératoires* represented in the assemblages of the Tennessee River valley, Savannah River valley, and Virginia Piedmont indicate significant inter-regional variation in Clovis bifacial technology and finished point morphology, and this evidence of variation in Clovis technology within the Southeast leads to the following conclusions : 1) through reduction, potential raw-material shape limitations were overcome in spite of inherent differences between the raw material conditions at each procurement site, and distinctions in point design were the intentional products of reduction techniques and strategies; 2) the variation found here goes beyond random individual variation; rather, it is variation in procedural aspects in the process of production leading to variation in production from start to finish; and 3) the evidence in this analysis is more congruent with the staging-area model, and based on this, the differences in the biface systems imply Clovis groups settled into increasingly disparate subregions and restructured the process of Clovis biface production while maintaining strong affinities to the original Clovis template.

With newly excavated sites, many of which are not kill sites, archaeologists have begun to realize that considerable variability existed in Clovis technology, subsistence, and settlement. Nowhere in North America has this change in perception been more evident than in the American Southeast. This dissertation presented new data on Clovis site occupation, technological organization, and settlement in the Southeast and demonstrated variability existed. Recognizing regional variation in the archaeological record is key to understanding Clovis origins and dispersal. We must continue to build and test models that account for important shared characteristics linking Clovis people across the continent but also explain the processes through which variation in Clovis lifeways developed.

REFERENCES

Anderson, David G.

1990 Paleoindian Colonization of Eastern North America: A View from the Southeastern United States. In *Early Paleoindian Economies of Eastern North America*, edited by Kenneth Tankersley and Barry Isaac, pp. 163-216. Research in Economic Anthropology Supplement 5. JAI Press, Greenwich, Connecticut.

1991 Examining Prehistoric Settlement Distribution in Eastern North America. *Archaeology of Eastern North America* 19:1-22.

1995 Paleoindian Interaction Networks in the Eastern Woodlands. In *Native American Interaction: Multiscalar Analyses and Interpretations in the Eastern Woodlands*, edited by Michael S. Nassaney and Kenneth E. Sassaman, pp. 1-26. University of Tennessee Press, Knoxville.

1996 Models of Paleoindian and Early Archaic Settlement in the Lower Southeast. In *The Paleoindian and Early Archaic Southeast*, edited by David G. Anderson and Kenneth Sassaman, pp. 29-57. University of Alabama Press, Tuscaloosa.

2004 Paleoindian Occupations in the Southeastern United States. In *New Perspectives on the First Americans,* edited by Bradley T. Lepper and Robson Bonnichsen, pp. 119-128. Center for the Study of the First Americans, College Station.

2005 Pleistocene Human Occupation of the Southeastern United States: Research Directions for the Early 21st Century. In *Paleoamerican Origins: Beyond Clovis*, edited by Robson Bonnichsen, Bradley T. Lepper, Dennis Stanford, and Michael R. Waters, pp. 29-42. Texas A&M University Press, College Station.

Anderson, David G., D. Shane Miller, Stephen J. Yerka, and Michael K. Faught

2005 Paleoindian Database of the Americas: 2005 Status Report. *Current Research in the Pleistocene* 22:91-92.

Anderson, David G., D. Shane Miller, Stephen J. Yerka, J. Christopher Gillam, Erik N. Johanson, Derek T. Anderson, and Ashley M. Smallwood

2010 Paleoindians in North America: Evidence from PIDBA (Paleoindian Database of the Americas). *Archaeology of Eastern North America* 38:63-90.

Andrefsky, William, Jr.

2005 *Lithics: Macroscopic Approaches to Analysis*. Second Edition. Cambridge University Press, Cambridge.

Bamforth, Douglas B.

2003 Rethinking the Role of Bifacial Technology in Paleoindian Adaptations on the Great Plains. In *Multiple Approaches to the Study of Bifacial Technologies*, edited by Marie Soressi and Harold L. Dibble, pp. 209-228. University of Pennsylvania, Philadelphia.

Bamforth, Douglas B.

2007 *The Allen Site: A Paleoindian Camp in Southwestern Nebraska*. University of New Mexico Press, Albuquerque.

Bamforth, Douglas B., and Keri Hicks

2008 Production Skill and Paleoindian Workgroup Organization in the Medicine Creek Drainage, Southwestern Nebraska. *Journal Archaeological Method Theory* 15:132-153.

Baxter, M.J., and C.C. Beardah

1997 Some Archaeological Applications of Kernel Density Estimates. *Journal of Archaeological Science* 24:347-354.

Beaton, J. M.

1991 Colonizing Continents: Some Problems from Australia and the Americas. In *The First Americans: Search and Research*, edited by T. D. Dillehay and D. J. Meltzer, pp. 209-230. CRC Press, Boca Raton, Florida.

Bement, Leeland, C., and Brian J. Carter

2010 Jake Bluff: Clovis Bison Hunting on the Southern Plains of North America. *American Antiquity* 75:907-934.

Benthall, Joseph, L., and Ben C. McCary

1973 The Williamson Site: A New Approach. *Archaeology of Eastern North America* 1(1):127-134.

Bettinger, Robert L., and Jelmer Eerkens

1999 Point Typologies, Cultural Transmission, and the Sread of Bow-and-Arrow Technology in Prehistoric Great Basin. *American Antiquity* 64(2):231-242.

Bever, Michael R., and David J. Meltzer

2007 Exploring Variation in Paleoindian Life Ways: The Third Revised Edition of the Texas Clovis Fluted Point Survey. *Bulletin of the Texas Archeological Society* 78:65-99.

Bordes, François

1967 *The Old Stone Age*. McGraw-Hill, New York.

Bradley, Bruce A.

1991 Flaked Stone Technology and Typology in the Northern High Plains. In *Prehistoric Hunters of the High Plains*, 2nd Edition, edited by George C. Frison, pp. 369-395. Academic Press, New York.

1993 Paleoindian Flaked Stone Technology in the North American High Plains. In *From Kostenki to Clovis: Upper Paleolithic-Paleoindian Adaptations*, edited by O. Soffer and N. Praslov, pp. 251-262. Inter-disciplinary Contribution to Archaeology. Plenum Press, New York.

Bradley, Bruce A., and Dennis Stanford

2004 The North Atlantic Ice-Edge Corridor: A Possible Paleolithic Route to the New World. *World Archaeology* 36(4):459-78.

2006 The Solutrean-Clovis Connection: Reply to Straus, Meltzer and Goebel. *World Archaeology* 38(4):704-714.

Bradley, Bruce A., Michael B. Collins, and Andrew Hemmings

2010 *Clovis Technology*. Archaeological Series 17, International Monographs in Prehistory, Ann Arbor, Michigan.

Breitburg, Emanuel, and John Broster

1994 Paleoindian Site, Lithic, and Mastodon Distributions in Tennessee. *Current Research in the Pleistocene* 11:9-11.

Broster, John B., and Mark R. Norton

1992 Paleoindian Projectile Point and Site Survey in Tennessee: 1988-1992. In *Paleoindian and Early Archaic Period Research in the Lower Southeast: A South Carolina Perspective,* edited by David G. Anderson, Kenneth E. Sassaman, and Christopher Judge, pp. 263-268. Council of South Carolina Professional Archaeologists, Columbia.

1993 The Carson-Conn-Short Site (40BN190): An Extensive Clovis Habitation in Benton County, Tennessee. *Current Research in the Pleistocene* 10:3-4.

1996 Recent Paleoindian Research in Tennessee. In *The Paleoindian and Early Archaic Southeast*, edited by David G. Anderson and Kenneth Sassaman, pp. 288-297. University of Alabama Press, Tuscaloosa.

Broster, John B., Mark R. Norton, Dennis J. Stanford, C. Vance Haynes, Jr., and Margaret A. Jodry

1994 Eastern Clovis Adaptations in the Tennessee River Valley. *Current Research in the Pleistocene* 11:12-13.

1996 Stratified Fluted Point Deposits in the Western Valley of Tennessee. *Proceedings of the 14th Annual Mid-South Archaeological Conference Special Publications 1:*1-11.

Butler, B. R.,

1963 An Early Man Site at Big Camas Prairie, South-Central Idaho. *Tebiwa* 6:22-33.

Callahan, E.

1979 The Basis of Biface Knapping in the Eastern Fluted Point Tradition: A Manual for Flintknappers and Lithic Analysts. *Archaeology of Eastern North America* 7:1-180.

Cannon M.D., and D.J. Meltzer

2008 Explaining Variability in Early Paleoindian Foraging. *Quaternary International* 191, 5-17.

Cattelain, P.

1997 Hunting During the Upper Paleolithic: Bow, Spearthrower, or Both? In *Projectile Technology*, edited by Heidi Knecht, pp. 213-240. Plenum Press, New York.

Collins, Michael B.

1999 *Clovis Blade Technology: A Comparative Study of the Keven Davis Cache.* University of Texas Press, Austin.

2002 The Gault Site, Texas, and Clovis Research. *Athena Review* 3(2, 31-41):100-102.

2007 Discerning Clovis Subsistence from Stone Artifacts and Site Distributions on the Southern Plains Periphery. In *Foragers of the Terminal Pleistocene*, edited by Renee B. Walker and Boyce N. Driskell, pp. 59-87. University of Nebraska Press, Lincoln.

Collins, Michael B., and Andrew C. Hemmings

2005 Lesser-known Clovis Diagnostic Artifacts I: The Bifaces. *La Tierra* 32 (2):9-20.

Collins M.B., and John C. Lohse

2004 The Nature of Clovis Blades and Blade Cores. In *Entering America: Northeast Asia and Beringia Before the Last Glacial Maximum*, edited by David B. Madsen, pp. 159-183. University of Utah Press, Salt Lake City.

Collins, M.B., D.B. Hudler, and S.L. Black

2003 *Pavo Real (41BX52): A Paleoindian and Archaic Camp and Workshop on the Balcones Escarpment, South-Central Texas*. Studies in Archaeology 41, Texas Archeological Research Laboratory, The University of Texas at Austin and Archeological Studies Program, Report 50, Environmental Affairs Division, Texas Department of Transportation.

Collins, Michael B., Dale B. Hudler, and Stephen L. Black

2003 Research Design for Pavo Real. In *Pavo Real (41BX52): A Paleoindian and Archaic Camp and Workshop on the Balcones Escarpment, South-Central Texas,* edited by Michael B. Collins, Dale B. Hudler, and Stephen L. Black, pp.7-21. Studies in Archeology 41, Texas Archeological Research Laboratory, The University of Texas at Austin and Archeological Studies Program, Report 50, Environmental Affairs Division, Texas Department of Transportation, Austin.

Collins, Michael B., John Lohse, and Marilyn Shoberg

2007 The de Graffenried Collection: A Clovis Biface Cache from the Gault Site, Central Texas. *Bulletin of the Texas Archeological Society* 78:101-123.

Cox, Steven L.

1986 A Re-analysis of the Shoop Site. *Archaeology of Eastern North America* 14:101-139.

Crabtree, D.E.

1972 *An Introduction to Flintworking.* Occasional Papers of the Idaho University Museum, No. 28, Pocatello.

Daniel, I. Randolph, Jr.

2001 Stone Raw Material Availability and Early Archaic Settlement in the Southeastern United States. *American Antiquity* 66(2):237-265.

Daniel, I. Randolph, Jr., and Albert C. Goodyear

2006 An Update on the North Carolina Fluted Point Survey. *Current Research in the Pleistocene* 23:88-90.

Daniel, I. Randolph, Jr., and J. Robert Butler

1996 An Archaeological Survey and Petrographic Description of Rhyolite Sources in the Uwharrie Mountains, North Carolina. *Southern Indian Studies* 45:1-37.

Daniel, I. Randolph, Jr., and Michael Wisenbaker

1989 Paleoindian in the Southeast: The View from Harney Flats. In *Eastern Paleoindian Lithic Resource Use,* edited by C. Ellis and J. Lothrop, pp. 323-344. Westview, Boulder, Colorado.

Delcourt, Hazel R., and Paul A. Delcourt

1985 Quaternary Palynology and Vegetational History of the Southeastern United States. In *Pollen Records of the Late-Quaternary North American Sediments*, edited by V. M. Bryant and R. G. Holloway, pp.1-37. American Association of Stratigraphic Palynologists Foundation. Dallas, Texas.

Delcourt, Hazel R., Paul A. Delcourt, and Thompson Webb, III

1983 Dynamic Plant Ecology: The Spectrum of Vegetational Change in Space and Time. *Quaternary Science Reviews* 1:153-75.

Delcourt, Paul A., and Hazel R. Delcourt

1987 *Long Term Dynamics of the Temperate Zone: A Case Study of Late Quaternary Forests in Eastern North America*. Springer-Verlag, New York.

Dibble, Harold L., and Nicolas Rolland

1992 On Assemblage Variability in the Middle Paleolithic of Western Europe: History, Perspectives, and a New Synthesis. In *The Middle Paleolithc: Adaptation, Behavior, and Variability*, edited by Harold L. Dibble and Paul Mellars, pp. 1-28. University Museum Symposium Series, Vol. IV. University of Pennsylvania, Philadelphia.

Dickens, W.A.

2005 Biface Reduction and Blade Manufacture at the Gault Site (41BL323): A Clovis Occupation in Bell County, Texas. Unpublished Ph.D. dissertation, Texas A&M University, College Station.

Dillehay, Tom D.

2009 Probing Deeper into First American Studies. *PNAS* 106(4):971-978.

Dunbar, James S.

2006 Paleoindian Archaeology. In *First Floridians and Last Mastodons: The Page-Ladson Site in the Aucilla River*, edited by S. David Webb, pp. 403-435. Florida Museum of Natural History, University of Florida, Gainesville.

Eerkens, Jelmer, and Robert L. Bettinger

2001 Techniques for Assessing Standardization in Artifact Assemblages: Can We Scale Material Variability? *American Antiquity* 66:493-504.

Ellis, Christopher J.

1997 Factors Influencing the Use of Stone Projectile Tips: An Ethnographic Perspective. In *Projectile Technology*, edited by Heidi Knecht, pp. 37-78. Plenum Press, New York.

2004 Hi-Lo: An Early Lithic Complex in the Great Lakes Region. In *The Late Paleo-Indian Great Lakes*, edited by Lawrence J. Jackson and Andrew Hinshelwood, pp. 57-83. Mercury Series Archaeology Paper no. 165. Canadian Museum of Civilization, Gatineau, Quebec.

Ellis, Christopher, Albert C. Goodyear, Dan F. Morse, and Kenneth B. Tankersley

1998 Archaeology of the Pleistocene-Holocene Transition in Eastern North America. *Quaternary International* 49/50, 151-160.

Elston, R.G., and P.J. Brantingham

2002 Microlithic Technology in Northern Asia: A Risk-Minimizing Strategy of the Late Paleolithic and Early Holocene. In *Thinking Small: Global Perspectives on Microlithization*, edited by R. G. Elston and S. L. Kuhn, pp. 103-115. Archeological Papers of the AAA, vol. 12. American Anthropological Association, Arlington, Virginia.

Eren, Metin I., Stan Vanderlaan, and John Holland

2011 Overshot Flaking at the Arc Site, Genesee County, New York: Examining the Clovis-Gainey Connection. *The Open Anthropology Journal* 4:40-52.

Faught, Michael K.

2006 Paleoindian Archaeology in Florida and Panama: Two Circumgulf Regions Exhibiting Waisted Lanceolate Projectile Points. In *Paleoindian Archaeology: A Hemispheric Perspective*, edited by J. Morrow and C. Gnecco, pp. 164-184. University Press of Florida, Gainesville.

Fiedel, Stuart J.

2004 Rapid Migrations by Arctic Hunting Peoples: Clovis and Thule. In *Settlement of the American Continents: A Multidisciplinary Approach to Human Biogeography,* edited by C. M. Barton, G. A. Clark, D. R. Yesner, and G. A. Pearson, pp. 79-84. The University of Arizona Press, Tucson.

Figgins, Jesse D.

1933 A Further Contribution to the Antiquity of Man in America. *Proceedings of the Colorado Museum of Natural History* XII(2):4-10.

Flenniken, J. J.

1985 Stone Tool Reduction Techniques as Cultural Markers. In *Stone Tool Analysis: Essays in Honor of Don E. Crabtree*, pp. 91-132. University of New Mexico Press, Albuquerque.

Freeman, Andrea K. L., Edward E. Smith, Jr., and Kenneth B. Tankersley

1996 A Stone's Throw from Kimmswick: Clovis Period Research in Kentucky. In *The Paleoindian and Early Archaic Southeast*, edited by David G. Anderson and Kenneth E. Sassaman, pp. 385-403. The University of Alabama Press, Tuscaloosa, Alabama.

Frison, George C.

1968 A Functional Analysis of Certain Chipped Stone Tools. *American Antiquity* 33(2):149-155.

1978 *Prehistoric Hunters of the High Plains*. 1st edition. Academic Press, Inc., San Diego.

1991 *Prehistoric Hunters of the High Plains*. 2nd edition. Academic Press, Inc., San Diego.

Frison, George C., and Bruce A. Bradley

1999 *The Fenn Cache: Clovis Weapons and Tools*. One Horse Land and Cattle Compnay, Santa Fe, New Mexico.

Frison, George, and Lawrence Todd

1986 *The Colby Mammoth Site: Taphonomy and Archaeology of a Clovis Kill in Northern Wyoming*. University of New Mexico Press, Albuquerque.

Goebel, Ted, Michael R. Waters, and Dennis H. O'Rourke

2008 The Late Pleistocene Dispersal of Modern Humans in the Americas. *Science* 319:1497-1502.

Goodyear, Albert C., III

1989 A Hypothesis for the Use of Cryptocrystalline Raw Materials Among Paleoindian Groups of North America. In *Eastern Paleoindian Lithic Resource Use,* edited by C. Ellis and J. C. Lothrop, pp. 1-9. Westview, Boulder, Colorado.

1993 Tool Kit Entropy and Bipolar Reduction: A Study of Interassemblage Lithic Variability Among Paleo-Indian Sites in the Northeastern United States. *North American Archaeologist* 14:1-23.

1999 The Early Holocene Occupation of the Southeastern United States: A Geoarchaeological Summary. In *Ice Age Peoples of North America: Environments, Origins, and Adaptations of the First Americans*, edited by R. Bonnichsen and K. L. Turnmire, pp. 432-481. Oregon State University Press, Corvallis.

2005a The Allendale-Brier Creek Clovis Complex: A Clovis Center in the Middle Savannah River Valley. Paper presented at the 62nd Annual Meeting of the Southeastern Archaeological Conference, November 2005, Columbia, South Carolina.

2005b Evidence for Pre-Clovis Sites in the Eastern United States. In *Paleoamerican Origins: Beyond Clovis*, edited by R. Bonnichsen, B. Bradley, D. Stanford, and M. Waters, pp. 103-112. Center for the Study of the First Americans, Texas A&M University.

2006 Recognizing the Redstone Fluted Point in the South Carolina Paleoindian Point Database. *Current Research in the Pleistocene* 23:112-114.

Goodyear, Albert C. III, and Tommy Charles

1984 *An Archaeological Survey of Chert Quarries in Western Allendale County, South Carolina*. Research Manuscript Series 195. South Carolina Institute of Archaeology and Anthropology, University of South Carolina, Columbia.

Goodyear, Albert C., III, and Kenn Steffy

2003 Evidence of a Clovis Occupation at the Topper Site, 38AL23, Allendale County, South Carolina. *Current Research in the Pleistocene* 20:23-25.

Goodyear, Albert C., III, Keith Derting, D. Shane Miller, and Ashley M. Smallwood

2009 Exotic Clovis Lithics from the Topper Site, 38AL23, Allendale County, South Carolina. *Current Research in the Pleistocene* 26:60-62.

Goodyear, Albert C., III, James L. Michie, and Tommy Charles

1990 *The Earliest South Carolinians, The Paleoindian Occupation of South Carolina*. The Archaeological Society of South Carolina, Inc. Occasional Papers No. 2.

Goodyear, Albert C., III, D. Shane Miller, and Ashley Smallwood

2007 Introducing Clovis at the Topper Site, 38AL23, Allendale County, South Carolina. Paper presented at the 72nd Annual Meeting of the Society for American Archaeology, April 27, 2007, Austin, Texas.

Goodyear, Albert C., Sam B. Upchurch, Mark J. Brooks, and Nancy N. Goodyear

1983 Paleo-Indian Manifestations in the Tampa Bay Region, Florida. *The Florida Anthropologist* 36(1-2):40-66.

Gramly, Richard M., and Carl Yahnig

1991 The Adams Site (15Ch90) and the Little River, Christian County, Kentucky, Clovis Workshop Complex. *Southeastern Archaeology* 10:134-45.

Greaves, Russell D.

1997 Hunting and Multifunctional Use of Bows and Arrows: Ethnoarchaeology of Technological Organization Among Pume Hunters of Venezuela. In *Projectile Technology*, edited by Heidi Knecht, pp. 287-320. Plenum Press, New York.

Green, F.E.

1963 The Clovis Blades: An Important Addition to the Llano Complex. *American Antiquity*, 29(2):145-165.

Hannus, L.A.

1985 The Lange/Ferguson Site – An Event of Clovis Mammoth Butchery with the Associated Bone Tool Technology: The Mammoth and its Track. Unpublished Ph.D. dissertation, University of Utah, Salt Lake.

Haury, Emil W., Ernst Antevs, and John F. Lance

1953 Artifacts with Mammoth Remains, Naco, Arizona. *American Antiquity* 19(1):1-24.

Haury, Emil W., E.B. Sayles, and William W. Wasley

1959 The Lehner Mammoth Site, Southeastern Arizona. *American Antiquity* 25(1), 2-30.

Haynes, C. V., Jr.

1964 Fluted Projectile Points: Their Age and Dispersion. *Science* 145:1408-1413.

1972 Stratigraphic Investigations at the Williamson Site, Dinwiddie County, Virginia. *The Chesopiean* 10(4):107-113.

1982 Were Clovis Progenitors in Beringia? *Paleoecology of Beringia*, edited by D. M. Hopkins, J. V. Matthews, Jr., C. E. Schweger, and S. B. Young, pp. 383-389. Academic Press, New York.

Haynes, C. V., Jr., and B. B. Huckell

2007 *Murray Springs: A Clovis Site with Multiple Activity Areas in the San Pedro Valley, Arizona*. University of Arizona, Tuscon.

Haynes, Gary

2002 *The Early Settlement of North America: The Clovis Era*. Cambridge University Press, Cambridge.

Hemmings, C. Andrew

1999 The Paleoindian and Early Archaic Tools of Sloth Hole (8JE121): An Inundated Site in the Lower Aucilla River, Jefferson County, Florida. Unpublished M.A. thesis, Department of Anthropology, University of Florida, Gainesville.

Hester, James J.

1972 *Blackwater Locality No. 1*. Fort Burgwin Research Center SMU, Ranchos de Taos, New Mexico.

Hill, Phillip J.

1997 A Re-examination of the Williamson Site in Dinwiddie County, Virginia: An Interpretation of Intrasite Variation. *Archaeology of Eastern North America* 25:159-173.

Hofman, Jack L.

1987 Hopewell Blades from the Twenhafel: Distinguishing Local and Foreign Core Technology. In *The Organization of Core Technology*, edited by Jay K. Johnson, pp. 87-118. Westview Press, Boulder, Colorado.

Holliday V.T., C.V. Haynes, J.L. Hofman, and D.J. Meltzer

1994 Geoarchaeology and Geochronology of the Miami (Clovis) Site, Southern High Plains of Texas. *Quaternary Research* 41: 234-244.

Howard, E.B.

1933 Association of Artifacts with Mammoth and Bison in Eastern New Mexico. *Science* 78:524.

Huckell, B.B.

2007 Clovis Lithic Technology: A View from the Upper San Pedro Valley. In *Murray Springs: A Clovis Site with Multiple Activity Areas in the San Pedro Valley, Arizona*, edited by C. V. Haynes, Jr. and B. B. Huckell, pp. 170-213. University of Arizona, Tuscon.

Johnson, Eileen

1987 *Lubbock Lake*. Texas A&M University Press, College Station, Texas.

Joyce, D.J.

2006 Chronology and New Research on the Schaefer Mammoth (*Mammuthus primigenius*) Site, Kenosha County, Wisconsin, USA. *Quaternary International* 142-143:44-57.

Leonhardy, Frank C.

1966 *Domebo: A Paleoindian Mammoth Kill in the Prairie Plains.* Museum of the Great Plains, Lawton, Oklahoma.

Keeley, Lawrence H.

1980 *Experimental Determination of Stone Tool Uses*. University of Chicago Press, Chicago.

Kelly, Robert L.

1988 The Three Sides of a Biface. *American Antiquity* 53:717-734.

1996 Ethnographic Analogy and Migration to the Western Hemisphere. In *Prehistoric Mongoloid Dispersals*, edited by T. Akazawa and E. J. Szathmary, pp. 229-240. Oxford University Press, Oxford.

Kelly, Robert L., and Lawrence C. Todd

1988 Coming into the Country: Early Paleoindian Hunting and Mobility. *American Antiquity* 53(2):231-244.

2003 Maybe We Do Know When People First Came to North America, and What Does It Mean If We Do? *Quaternary International* 109-110:1345.

Kintigh, Keith W., and Albert J. Ammerman

1982 Archaeology Heuristic Approaches to Spatial Analysis in Archaeology. *American Antiquity* 47(1):31-63.

Kuhn, Steven L.

1990 A Geometric Index of Reduction for Unifacial Stone Tools. *Journal of Archaeological Science* 17:585-593.

Lahren, L. A., and R. Bonnichsen

1974 Bone Foreshafts from a Clovis Burial in Southwestern Montana. *Science* 186:147-150.

Larson, M. L.

1994 Toward a Hollistic Analysis of Chipped Stone Assemblages. In *Raw Material Economies among Hunter-Gatherers*, edited by A. Montet-White and S. Holen, pp. 7-31. University of Kansas Publications in Anthropology 19, Lawrence.

Lepper, Bradley T., and David J. Meltzer

1991 Late Pleistocene Human Occupation of the Eastern United States. In *Clovis Origins and Adaptations*, edited by R. Bonnichsen and K. L. Turnmire, pp. 175-184. Center for the Study of the First Americans, Oregon State Univeristy, Corvallis.

Lothrop, Jonathan C.

1989 The Organization of Paleoindian Lithic Technology at the Potts Site. In *Eastern Paleoindian Lithic Resource Use,* edited by C. Ellis and J. C. Lothrop, pp. 99-138. Westview, Boulder, Colorado.

MacDonald, George F.

1968 *Debert: A Paleo-Indian Site in Central Nova Scotia*. Anthropological Papers 16. National Museum of Canada, Ottawa.

Mace, R.

2005 Introduction: A Phylogenetic Approach to the Evolution of Cultural Diversity. In *The Evolution of Cultural Diversity: A Phylogenetic Approach*, edited by R. Mace, C. J. Holden, and S. Shennan, pp. 1-13. UCL Press, London.

Martin, P.S.

1973 The Discovery of America. *Science* 179:969-974.

McAvoy, Joseph M.

1992 *Nottoway River Survey: Part I: Clovis Settlement Patterns: The 30 Year Study of a Late Ice Age Hunting Culture on the Southern Interior Coastal Plain of Virginia*. Archeological Society of Virginia Special Publication, No. 28. Dietz Press, Richmond.

McAvoy, J.M., and L.D. McAvoy

1997 *Investigations of Site 44SX202, Cactus Hill, Sussex County, Virginia.* Research Report Series No.8, Virginia Department of Historic Resources, Richmond.

McCary, Ben

1975 The Williamson Paleo-Indian Site Dinwiddie County, Virginia. *The Chesopiean* 13(3-4):48-132.

Mehringer, P. J., Jr.

1988 Weapons Cache of Ancient Americans. *National Geographic* 174, 500-503.

Meltzer, David J.

1988 Late Pleistocene Human Adaptations in Eastern North America. *Journal of World Prehistory* 2:1-53.

2002 What Do You Do When No One’s Been There Before? Thoughts on the Exploration and Colonization of New Lands. In *The First Americans: The Pleistocene Colonization of the New World*, edited by N.G. Jablonski, pp. 27-58. California Academy of Sciences, San Francisco.

2004 Modeling the Initial Colonization of the Americas: Issues of Scale, Demography, and Landscape Learning. In *The Settlement of the American Continent: A Multidisciplinary Approach to Human Biogeography*, edited by C. Michael Barton, Geoffrey A. Clark, David R. Yesner, and Georges A. Pearson, pp. 123-137. University of Arizona Press, Tucson.

2009 *First Peoples in a New World: Colonizing Ice Age America*. University of California Press, Berkeley.

Miller, D. Shane

2007 Site Formation Processes in an Upland Paleoindian Site: The 2005-2007 Topper Firebreak Excavations. Unpublished M.A. thesis, Department of Anthropology, University of Tennessee, Knoxville.

2010 *Clovis Excavations at Topper 2005-2007: Examining Site Formation Processes at an Upland Paleoindian Site along the Middle Savannah River*. Occasional Papers, Southeastern Paleoamerican Survey, South Carolina Institute of Archaeology and Anthropology, University of South Carolina, Columbia.

Miller, D. Shane, and Albert C. Goodyear III

2008 A Probable Hafted Uniface from the Clovis Occupation at the Topper Site, 38AL23, Allendale County, South Carolina. *Current Research in the Pleistocene* 25:75-77.

Miller, D. Shane, and Ashley M. Smallwood

2010 Beyond Stages: Modeling Clovis Biface Production at the Topper Site (38AL23), South Carolina. In *Lithic Analysis: Problems, Solutions, and Interpretations*, edited by Philip J. Carr and Andrew P. Bradbury, Alabama Press, Tuscaloosa, Alabama, in press.

Morrow, Juliet E.

1995 Clovis Projectile Point Manufacture: A Perspective from the Ready/Lincoln Hills Site, 11JY46, Jersey County, Illinois. *Midcontinental Journal of Archaeology* 20:167-191.

1996 The Organization of Early Paleoindian Lithic Technologies in the Confluence Region of the Mississippi, Illinois, and Missouri Rivers. Unpublished Ph.D. dissertation, Department of Anthropology, Washington University, St. Louis.

Morrow, Juliet E., and Toby A. Morrow

1999 Geographic Variation in Fluted Projectile Points: A Hemispheric Perspective. *American Antiquity* 64(2):215-230.

Morse, Dan F., and Albert C. Goodyear, III

1973 The Significance of the Dalton Adze in Northeast Arkansas. *Plains Anthropologist* 18:316-322.

Mosimann, J.E. and P.S. Martin

1975 Simulating Overkill by Paleoindians. *American Scientist* 63:304-313.

Nami, Hugo G., Mark R. Norton, Dennis Stanford, and John B. Broster

1996 Comments on Eastern Clovis Lithic Technology at the Carson Conn Short Site (40BN190), Tennessee River Valley. *Current in the Pleistocene* 13:62-64.

O'Brien, M. J., J. Darwent, and R. L. Lyman

2001 Cladistics is Useful for Reconstructing Archaeological Phylogenies: Paleoindian Points from the Southeastern United States. *Journal of Archaeological Science* 28:1115-1136.

Odell, George H.

1989 Fitting Analytical Techniques to Prehistoric Problems. In *Alternative Approaches to Lithic Analysis*, edited by D. Henry and G. Odell, pp. 159-182. Archeological Papers of the American Anthropological Association, No.1. American Anthropological Association, Washington, D.C..

2003 *Lithic Analysis*. Springer, New York.

Otte, Marcel

2003 The Pitfalls of Using Bifaces as Cultural Markers. In *Multiple Approaches to the Study of Bifacial Technologies*, edited by Marie Soressi and Harold L. Dibble, pp. 183-193. University of Pennsylvania, Philadelphia.

Parry, W., and R. Kelly

1988 Expedient Core Technology and Sedentism. In *The Organization of Core Technology,* edited by J. Johnson and C. Morrow, pp. 285-304. Westview Press, Boulder, Colorado.

Peck, Rodney M.

1985 The Fields of Cattail Creek: An Up-date on the Williamson Site. In *The Williamson Site, Dinwiddie County, Virginia*, edited by Rodney M. Peck, pp.181-203. Rodney Peck Publisher, Harrisburg, North Carolina.

2004 *Eastern Fluted Points*. 3rd Edition. Rodney Peck Publisher, Kannapolis, North Carolina.

Pitblado, Bonnie L.

2011 A Tale of Two Migrations: Reconciling Recent Biological and Archaeological Evidence for the Pleistocene Peopling of the Americas. *Journal of Archaeological Research*, in press.

Prasciunas, Mary M.

2007 Bifacial Cores and Flake Production Efficiency: An Experimental Test of Technological Assumptions. *American Antiquity* 72(2):334-348.

2008 Clovis Projectile Point Distribution: Separating Behavior from Sample Bias. Unpublished Ph.D. dissertation, Department of Anthropology, University of Wyoming, Laramie.

Richerson, P., and R. Boyd

2005 *Not by Genes Alone: How Culture Transformed Human Evolution.* The University of Chicago Press, Chicago.

Sackett, James R.

1985 Style and Ethnicity in the Kalahari: A Reply to Wiessner. *American Antiquity* 50(1):154-159.

Sain, Douglas

2011 Blade Technology at the Topper Site (38AL23). Unpublished M.A. thesis, Department of Anthropology, Eastern New Mexico University, Portales.

Sanders, Thomas N.

1990 *Adams: The Manufacturing of Flaked Stone Tools at a Paleoindian Site in Western Kentucky*. Persimmon, Buffalo, New York.

Sellards, E.H.

1952 *Early Man in America: A Study in Prehistory*. The Texas Memorial Museum, University of Texas Press, Austin.

Sellet, Frédéric

1993 Chaîn Opératoire: The Concept and Its Applications. *Lithic Technology* 18(1&2):106-112.

Smallwood, Ashley M.

2010 Clovis Biface Technology at the Topper site, South Carolina: Evidence for Variation and Technological Flexibility. *Journal of Archaeological Science* 37:2413-2425.

Smallwood, Ashley M., and Albert C. Goodyear, III

2009 Reworked Clovis Biface Distal Fragments from the Topper Site, 38AL23: Implications for Clovis Technological Organization in the Central Savannah River Region. *Current Research in the Pleistocene* 26:118-120.

Smallwood, Ashley M., and D. Shane Miller

2009 Biface Technology at the Topper Site: Explaining the Variation and the Implications for Mobility. Paper presented on the 74th Annual Meeting of the Society for American Archaeology, April 26, 2009, Atlanta, Georgia.

Smallwood, Ashley M., D. Shane Miller, and Albert C. Goodyear, III

2008 A Spatial Analysis of Biface Reduction at the Topper Site, South Carolina. Paper presented at the 73rd Annual Meeting of the Society for American Archaeology, March 26, 2008, Vancouver, BC, Canada.

Smallwood, Ashley M., D. Shane Miller, and Doug Sain

2011 Topper Site, South Carolina: An Overview of the Clovis Lithic Assemblage. *Eastern Fluted Point Tradition*. University of New Mexico Press, Albuquerque, New Mexico, in press.

Smith, Heather Lynn

2010 A Behavioral Analysis of Clovis Point Morphology Using Geometric Morphometrics. Unpublished M.A. thesis, Department of Anthropology, Texas A&M University, College Station.

Sollberger, J.

1977 On Fluting Folsom: Notes on Recent Experiments. *Bulletin of the Texas Archeological Society* 48:47-52.

Stanford, Dennis J.

1991 Clovis Origins and Adaptations: An Introductory Perspective. In *Clovis Origins and Adaptations*, edited by R. Bonnichsen and K. L. Turnmire, pp. 1-14. Center for the Study of the First Americans, Oregon State University, Corvallis.

Stanford, Dennis J., and Margaret A. Jodry

1988 The Drake Clovis Cache. *Current Research in the Pleistocene* 5, 21-22.

Sullivan, Alan P., III

1992 Investigating the Archaeological Consequences of Short-Duration Occupations. *American Antiquity* 57(1):99-115.

Tankersley, Kenneth B.

1991 A Geoarchaeological Investigation of Distribution and Exchange in the Raw Material Economies of Clovis Groups in Eastern North America. In *Raw Material Economies Among Hunter-Gatherers*, edited by A. Montet-White and S. Holen, pp. 285-303. University of Kansas Publications in Anthropology 19, Lawrence.

2004 The Concept of Clovis and the Peopling of North America. In *The Settlement of the American Continent: A Multidisciplinary Approach to Human Biogeography*, edited by C. Michael Barton, Geoffrey A. Clark, David R. Yesner, and Georges A. Pearson, pp. 49-63. University of Arizona Press, Tucson.

Taylor-Montoya, John J.

2007 Quantitative Variation in Late Paleoindian Projectile Points: A Perspective from Central Texas. *Bulletin of the Texas Archeological Society* 78:161-176.

Thulman, David K.

2007 A Typology of Fluted Points from Florida. *The Florida Anthropologist* 60(4):165-177.

Waguespack, Nicole M.

2007 Why We're Still Arguing About the Pleistocene Occupation of the Americas. *Evolutionary Anthropology* 16:63-74.

Waters, Michael R., and Thomas W. Stafford, Jr.

2007 Redefining the Age of Clovis: Implications for the Peopling of the Americas. *Science* 315(5815):1122-1126.

Waters, Michael R., Steven L. Forman, Thomas W. Stafford, Jr., and John Foss

2009 Geoarchaeological Investigations at the Topper and Big Pine Tree Sites, Allendale County, South Carolina. *Journal of Archaeological Science* 36:1300-1311.

Waters, M. R., C. D Pevny, D. L. Carlson, W. A. Dickens, A. M. Smallwood, S. A. Minchak, E. Bartelink, J.M. Wiersema, J.E. Wiederhold, H.M. Luchsinger, D.A. Alexander, and T.A. Jennings

2011 *A Clovis Workshop in Central Texas: Archaeological Investigations of Excavation Area 8 at the Gault Site*. Texas A&M University Press, College Station, in press.

Wiessner, Polly

1983 Style and Social Information in the Kalahari San Projectile Points. *American Antiquity* 48(2):253-276.

Willey, G. R.

1953 Archaeological Theories and Interpretation: New World. In *Anthropology Today*, edited by A. L. Kroeber, pp. 361-385. University of Chicago Press, Chicago.

Willig, Judith A.

1991 Clovis Technology and Adaptation in Far Western North America: Regional Pattern and Environmental Context. In *Clovis Origins and Adaptations,* edited by R. Bonnichsen and K. L. Turnmire, pp. 91-119. Center for the Study of the First Americans, Oregon State University, Corvallis.

1996 Environmental Context for Early Human Occupation in Western North America. In *Prehistoric Mongoloid Dispersals*, edited by T. Akazawa and E. J. Szathmary, pp. 241-253. Oxford University Press, Oxford.

Wormington, H. Marie

1957 *Ancient Man in North America*. Denver Museum of Natural History, Popular Series 4. Peerless, Denver, Colorado.

Yu, Pei-Lin

2006 From Atlatl to Bow and Arrow: Implicating Projectile Technology in Changing Systems of Hunter-Gatherer Mobility. In *Archaeology and Ethnoarchaeology of Mobility*, edited by Frederic Sellet, Russell Greaves, and Pei-Lin Yu, pp. 210-220. University Press of Florida, Gainesville.

VITA

Name: Ashley Michelle Smallwood

Address: Texas A&M University
TAMU 4352, College Station, TX 77843-4352

Email Address: smallwood.ashley@gmail.com

Education: B.A., Anthropology, Texas A&M University, 2003

M.A., Anthropology, Texas A&M University, 2006

Ph.D., Anthropology, Texas A&M University, 2011

Related Publications:

Smallwood, Ashley M. (2010) Clovis Biface Technology at the Topper Site, South Carolina: Evidence for Variation and Technological Flexibility. *Journal of Archaeological Science* 37:2413-2425.

Smallwood, Ashley M., and Albert C. Goodyear (2009) Reworked Clovis Biface Distal Fragments from the Topper Site, 38AL23: Implications for Clovis Technological Organization in the Central Savannah River Region. *Current Research in the Pleistocene* 26:118-120.

Smallwood, Ashley M. (submitted and in review) Clovis Technology and Settlement in the American Southeast: Using Biface Analysis to Evaluate Dispersal Models. *American Antiquity*.

Grants Awarded:

Smallwood, Ashley M. (2008) Doctoral Dissertation Improvement Grant: *Clovis Settlement Behavior in the American Southeast: Using Lithic Artifact Analysis to Evaluate the Staging-Area Model,* Archaeology NSF Grant, $10,199