

SETTLING INTO THE YOUNGER DRYAS: HUMAN BEHAVIORAL ADAPTATIONS
DURING THE PLEISTOCENE TO HOLOCENE TRANSITION IN THE MIDSOUTH
UNITED STATES

A Dissertation

by

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ABSTRACT

This dissertation investigates the evolution of Paleoindian adaptations during the Pleistocene to Holocene transition in the Midsouth United States. Evidence suggests that lithic technologies became more regionalized over time as territorial ranges constricted and people relied increasingly on locally available resources.

Following a brief introduction to the issues related to Paleoindian adaptations in Chapter one, I evaluate the evidence for pre-Clovis occupation at the Coats-Hines-Litchy site, in Tennessee. I conclude that based on analyses of geochronology, site formation processes, and the lithic assemblage, the site likely predates human occupation of North America, the faunal assemblage is naturally produced, and the artifact assemblage has been redeposited from other nearby sites. I next present a lithic analysis characterizing the range of variation and reduction sequence of Cumberland fluted bifaces from the Midsouth. I contend that standardization of basal elements reflect hafting requirements, and patterns of biface morphology, breakage, and resharpening reflect that Cumberland bifaces were designed specifically for piercing rather than to be multifunctional. I then compare Clovis, Cumberland, and Dalton biface technologies from Tennessee to investigate the evolution of Paleoindian adaptations during the Pleistocene to Holocene transition. I show that temporal changes in technological organization, landscape use, and toolstone selection reflect settling in processes associated with landscape learning rather than Younger Dryas-related environmental changes.

Ultimately, this dissertation presents new data related to the late Pleistocene occupation of the Midsouth and the evolution of regional Paleoindian adaptations. By recognizing temporal and spatial changes in late Pleistocene technologies, and considering those changes in relation to paleoecological records, we are better suited to understand Paleoindian adaptations. In turn, we are able to construct more robust and accurate settlement models to explain the peopling of the Americas.

DEDICATION

To Mom, for supporting me through all of the twists and turns.

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CHAPTER I

INTRODUCTION

The process of familiarization with, and adaptation to, new environments is integral to human colonization and settlement of previously unknown areas (Rockman and Steele 2003). Most archaeologists agree that this process began in the Americas when people first migrated south out of Beringia and into what is now Canada and the continental United States. As the initial human migration pushed further into North America people encountered different ecosystems that required flexibility and adaptation to cope with the advantages and disadvantages of regionally specific resource structures. As people were becoming increasingly familiar with their environments, dynamic climate conditions during the terminal Pleistocene, at least in some regions, further exacerbated the challenges of landscape learning.

Multiple settlement models have been constructed to understand the nature of human migration into and throughout the Americas (e.g., Anderson 1990, 1996; Kelly and Todd 1988; Meltzer 2004). The variation in these models highlights the ecological diversity that late Pleistocene foragers experienced, and the versatility required to successfully colonize new landscapes. Recently, Smallwood (2012) evaluated two alternative settlement models to understand the colonization of the southeast United States. Kelly and Todd's (1988) high-technology forager model suggests that Clovis populations were highly mobile, "technologically-oriented" foragers who relied on predictable ungulate behavior to move rapidly through different environments.

Anderson's (1990, 1996) staging-area model suggests that settlement occurred at a slower pace as "place-oriented" foragers habitually exploited resource-rich areas and regularly aggregated to share information and reaffirm social networks.

It is unlikely that a single settlement model can explain the colonization of an area as large and ecologically diverse as North America. Rather, multiple models are needed to explain regionally specific adaptations required to successfully colonize the continent. Smallwood's (2012) study of Clovis biface technology in the Southeast identified incipient regionalization in biface reduction methods, and offers support for the staging-area model. Habitually exploited resource-rich areas became centers for aggregating macroband populations and subsequently became demographic foundations for ensuing post-Clovis technologies (Smallwood 2012). Thulman (2006) found a similar pattern in northern Florida where Paleoindian biface designs appear to reflect a place-oriented settlement strategy. An increase in morphological variation of bifaces suggests that territorial ranges were becoming more constricted through time as Paleoindian populations were settling in to local landscapes (Thulman 2006).

In spite of having some of the densest concentrations of Paleoindian artifacts in North America, the precise chronology of Paleoindian technologies in the Midsouth is not clear (Anderson et al. 2010, 2015). Securely dated Paleoindian components are exceptionally rare in the region (Miller and Gingerich 2013). Limited sedimentation, high humidity, and soil acidity have generally prevented the preservation of radiocarbon dateable materials (Dunnell 1990; Miller and Gingerich 2013). Therefore, based largely on dated chronologies of neighboring regions, most archaeologists in the Midsouth

generally accept a Paleoindian sequence of Clovis, post-Clovis fluted, and post-Clovis unfluted lanceolate forms (e.g., Anderson and Sassaman 1996; Anderson et al. 2010, 2015; Bradley et al. 2008; Ellis and Deller 1997; Meltzer 2009). It should be noted, however, not everyone agrees with this sequence (Gramly 2013).

Climate was a significant and compounding factor in the peopling of the Americas. Central to this was the onset of the Younger Dryas (YD), which brought abrupt cooling and drying throughout much of the Northern Hemisphere, returning some regions to tundra-like conditions (Alley 2000; Broecker et al. 2010). The relationships between YD-driven environmental changes and modifications in human adaptations during the Pleistocene to Holocene transition have recently received much debate (e.g., Anderson et al. 2011; Ellis et al. 2011; Eren 2012; Holliday and Meltzer 2010; Meeks and Anderson 2012; Meltzer and Holliday 2010; Smallwood et al. 2015; Straus and Goebel 2011). While much of North America experienced the reversal of a general warming trend, regional paleoenvironmental data show substantial variation in local conditions (Ellis et al. 1998; Eren 2012; Straus and Goebel 2011; Meltzer and Holliday 2010). Modifications to Paleoindian adaptations were undoubtedly related to the local severity of the YD.

The lack of a well-established regional chronology complicates interpretations of diachronic adaptations and potential affects of the YD on Paleoindian demographics. Anderson and colleagues (2011; Meeks and Anderson 2012) suggest that the onset of the YD caused a significant decline or reorganization to population structure in the Southeast. Their hypothesis is based on a reduction in the frequency of hafted bifaces,

modifications to lithic procurement strategies, and analysis of radiocarbon-dated archaeological sites. Other researchers, however, contend that the YD may have gone unnoticed by human populations in the region (Eren 2012; Meltzer and Holliday 2010; Straus and Goebel 2011). Rather, factors such as sampling biases, typological errors, and a radiocarbon plateau at the onset of the YD may influence interpretations of perceived human responses (Eren 2012; Meltzer and Holliday 2010; Straus and Goebel 2011).

While there is a near absence of intact, buried sites in the Midsouth, there is an exceptionally robust record of Paleoindian artifacts from this region (Anderson et al. 2010, 2015). The variation present in those artifacts highlights the flexibility required in technological adaptations to successfully colonize and settle into the Midsouth during the Pleistocene to Holocene transition. To understand the evolution of those adaptations, I take a landscape perspective and view the distributions of, and variations in, Paleoindian technologies as reflections of the “spatial manifestation of the relations between humans and their environment” (Marquardt and Crumley 1987:1).

The overall objective of this research is to assess the evolution of Paleoindian adaptations in the Midsouth United States during the Pleistocene to Holocene transition. Did changes in environmental conditions at the onset of the YD drive the evolution of Paleoindian adaptations, or was there a gradual settling in through time as founding populations became increasingly familiar with local landscapes and resource availability? To understand the effects that the YD had on early human populations in the Midsouth, we must first establish a better understanding of cultural and technological adaptations before, during, and after the onset of the YD. Thus, I investigate a potential

pre-Clovis site in Tennessee (Coats-Hines-Litchy), and trace the evolution of biface technologies between Clovis, post-Clovis fluted (Cumberland), and post-Clovis unfluted (Dalton).

In Chapter II I present an evaluation of a potential pre-Clovis occupation at the site Coats-Hines-Litchy site. Coats-Hines-Litchy is located in Williamson County, Tennessee, and reportedly has direct evidence of human predation of extinct Pleistocene megafauna (Breitburg et al. 1996; Deter-Wolf et al. 2011). Multiple excavations over the last three decades have produced an intriguing artifact assemblage reportedly associated with the potentially butchered remains of a mastodon. Lithic artifacts were also identified during the excavation and during the laboratory processing of bulk sediment samples. One mastodon vertebrae excavated in 1994 was noted as having cutmarks (Breitburg et al. 1996). In addition to collecting new faunal, radiocarbon, geochemical, and geoarchaeological data, I also re-analyzed the previously excavated artifact assemblage. This information allowed me to assess the stratigraphic context, geochronology, and site formation processes at the site.

In Chapter III I present technological and morphological analyses of Cumberland fluted bifaces to characterize the range of variability present within this type. Cumberland fluted bifaces represent the instrument-assisted fluting horizon in the Midsouth, and are assumed to be generally contemporaneous with the beginning of the YD (e.g., Anderson et al. 2010, 2015; Broster et al. 2013; Ellis and Deller 1997; Fiedel 1999; Goodyear 1999; Meltzer 2009; Tankersley 1990, 1996). While these bifaces are prevalent throughout the Midsouth, they have only been recovered from surface or

disturbed contexts (Anderson et al. 2010, 2015; Goodyear 1999). I studied over 900 fluted Cumberland bifaces in public and private collections, as well as bifaces documented in the Paleoindian Database of the Americas (PIDBA). This enabled me to investigate patterns of biface production, use, and discard.

In Chapter IV I compare Clovis, Cumberland, and Dalton biface technologies from Tennessee. I use Paleoindian biface data compiled in PIDBA to test for changes in behavioral adaptations, and consider these changes in relation to the regional paleoenvironmental record. I compare patterns in technological organization, landscape use, and toolstone selection to assess the potential effects of the YD on Paleoindian adaptations in the Midsouth. These comparisons provide new information on the general life histories of each biface type, which, in turn, informs on Paleoindian adaptations before, during, and after the onset of the YD in the region.

Chapter V concludes the dissertation and with a brief summary of each chapter. I evaluate evidence for a potential pre-Clovis occupation at CHL, characterize variation within Cumberland bifaces from the Midsouth, and compare Clovis, Cumberland, and Dalton adaptations to assess the impact of the onset of the YD on regional populations. The research presented here will hopefully be a useful contribution to the field of archaeology, and further the understanding of Paleoindian adaptations in North America.

CHAPTER II

SITE FORMATION AND CONTEXT AT THE COATS-HINES-LITCHY SITE,
TENNESSEE: IMPLICATIONS FOR INTERPRETING PROPOSED PRE-LGM-AGE
ARCHAEOLOGICAL SITES

Introduction

Context is key to the accurate interpretation of the archaeological record. Understanding the geologic context of archaeological sites enables the correlation of artifacts, dates, and stratigraphy with site formation processes. This is especially pertinent in Paleoindian research where sites have been subjected to geomorphic processes since the late Pleistocene. Frequently these processes create mixed assemblages containing multiple archaeological components, and at times the remains of extinct fauna, that may be exposed to the surface or deeply buried. The accurate interpretation of site context, and ultimately the acceptance of early sites, requires a thorough geoarchaeological investigation.

The Coats-Hines-Litchy site (CHL), in Williamson County, Tennessee, has been previously proposed as a locale where people had direct interaction with extinct megafauna during the late Pleistocene (Breitburg et al. 1996; Deter-Wolf et al. 2011). Previous references refer to the site as “Coats-Hines,” but the site name has been updated here to reflect the generous support and stewardship of the current landowners. The site was first identified as a paleontological site in 1977 when the construction of a

golf course unearthed the disarticulated partial remains of a mastodon (Breitburg and Broster 1995). Subsequent excavations recovered the partial remains of additional disarticulated mastodons reported to be associated with stone tools and debitage.

A number of questions have remained outstanding regarding the geological context, age, and integrity of the site (Cannon and Meltzer 2004). What is the association between the faunal remains and lithic artifacts? What does the lithic assemblage look like? What is the geologic context of the site? What is the age of the site? As such, a large-scale, interdisciplinary investigation was initiated in 2012 to address these questions. In addition to collecting new faunal, radiocarbon, geochemical, and geoarchaeological data, the existing lithic assemblage was reanalyzed. This information is used to assess the human-mastodon association at CHL and provides a methodological and theoretical framework to evaluate other pre-Last Glacial Maximum (pre-LGM)-aged sites.

Background and Site History

Since 1977 investigations at CHL have identified three discrete locales (Areas A, B, and C) containing late Pleistocene faunal material eroding from an erosional channel (Figure 1; Deter-Wolf et al. 2011). Area A was first identified in 1977 when a salvage excavation, by the Tennessee Division of Archaeology (TDOA), was conducted to recover the partial remains of an American mastodon (*Mammuth americanum*). While the largest bones were individually excavated, smaller fragmentary pieces were recovered in

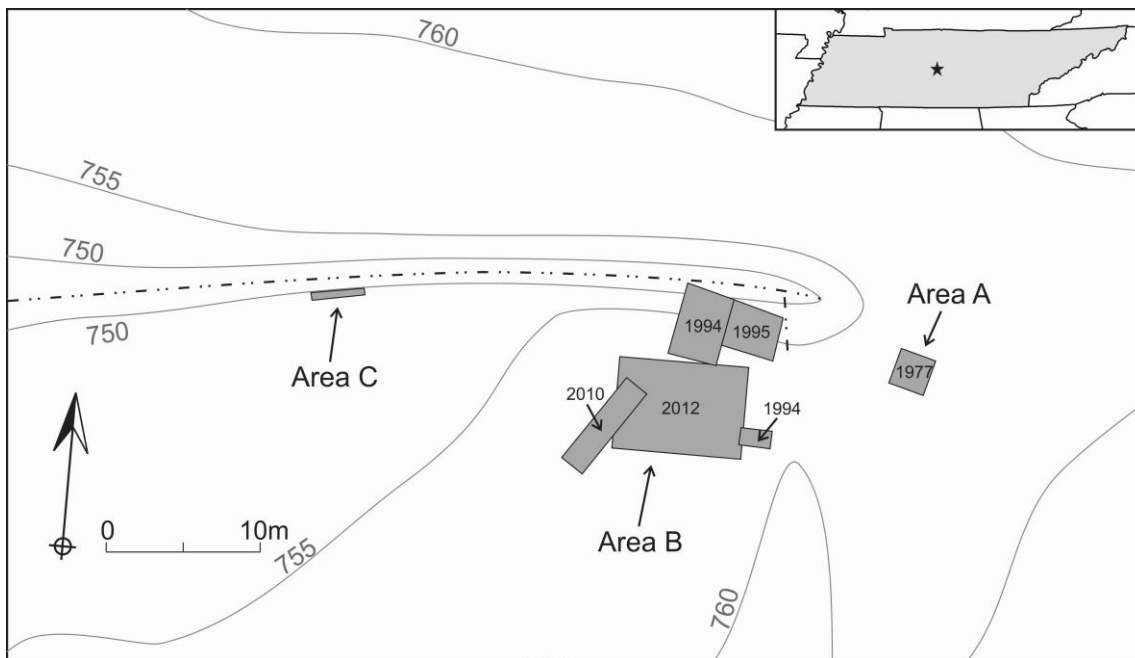


Figure 1. Map of the Coats-Hines-Litchy site with excavation areas A, B, and C.

bulk along with the sediment matrix encasing them. No artifacts were identified during the excavation; however, while processing bulk sediment samples from Area A lithic debitage was discovered (Deter-Wolf et al. 2011).

Area B was identified in 1994 prior to the establishment of a residential development. Between 1994 and 1995 (Figure 2) the site was systematically excavated to expose a late Pleistocene bone bed containing the disarticulated partial remains of a mastodon in addition to numerous other mammalian and reptilian species. Lithic artifacts were also identified during the excavation and during the processing of bulk sediment samples. One of the vertebrae excavated from Area B was noted as possessing cutmarks (Breitburg et al. 1996). Breitburg and colleagues (1996) suggest that stone

tools created the repeated, linear incisions during the removal of dorsal muscles. Other researchers contend that the marks may simply be the results of natural taphonomic processes (Cannon and Meltzer 2004).



Figure 2. Photograph of the Coats-Hines-Litchy site during excavation ca. March 1995 (facing West). Image courtesy of the Tennessee Division of Archaeology.

Area C was identified approximately 47 meters west of Area B during the 1994-1995 excavations. The poorly preserved remains of a third mastodon were identified eroding from the south side of the channel. The lack of preservation in Area C as compared to Areas A and B deterred excavations there. While large faunal remains are

frequently observed eroding from the bank, to date no artifacts have been recovered from Area C (Deter-Wolf et al. 2011).

In 2010 a small investigation trench was excavated over a period of four days. The primary objective of the 2010 investigation was to determine if Pleistocene-aged deposits remained intact at the site. To that end, the investigation was successful. The narrow, mechanically dug trench exposed Pleistocene sediments and bone fragments extending south from the 1994-1995 excavations. Undulations in the trench and ground surface limited the accuracy of vertical measurements, however, a generalized stratigraphic profile was recorded based on estimates below the ground surface (Deter-Wolf et al. 2011).

2012 Excavation

The 2012 excavation was conducted in Area B and intentionally situated to directly link all previous excavations in Area B (Figure 3). This assured the 2012 investigation was able to correlate all geologic deposits identified during previous excavations. The artifacts and faunal remains in previous excavations were identified as coming from a grey Pleistocene clay-rich deposit buried by approximately 2.5 meters of Holocene sediments and recent fill. To date, no cultural artifacts have been documented *in situ* in the upper 2.5 meters of sediment. As such, the upper approximately two meters of culturally sterile deposits were mechanically removed under close supervision prior to the 2012 excavation. After the culturally sterile Holocene sediments were removed, a

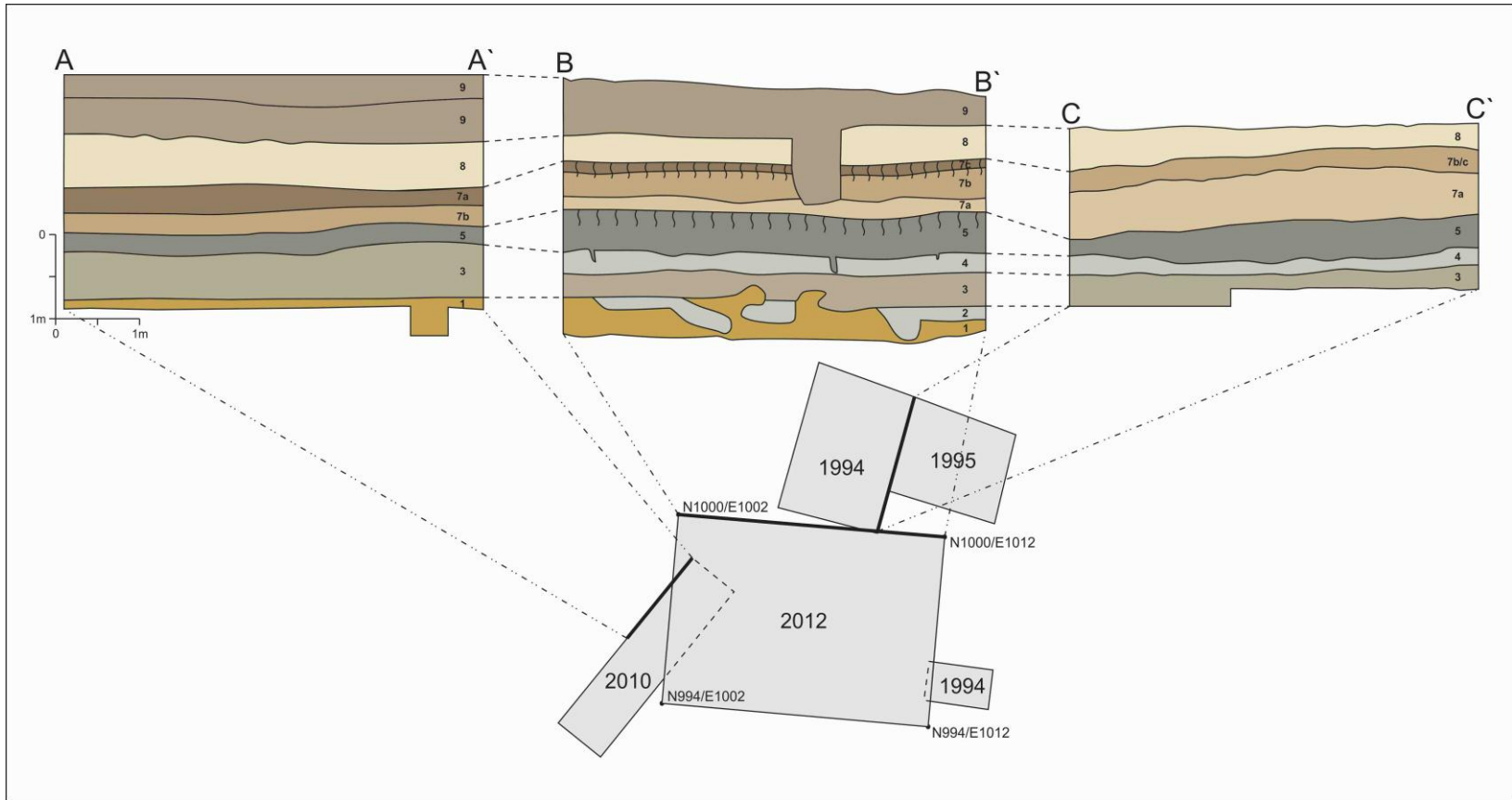


Figure 3. Coats-Hines-Litchy, Area B detail with correlations of 1994-1995, 2010, and 2012 stratigraphic profiles.

total of 43 square meters were excavated in 5 cm levels and all sediment water screened through 1/4-inch wire mesh.

The 2012 excavation had three objectives. First, a geoarchaeological study (Schmalle 2013) was conducted to interpret the depositional history of the site and the association between the mastodon remains and the lithic artifacts. Earlier descriptions of the stratigraphy at CHL did not thoroughly explain the geologic setting of the bonebed. Second, to recover organic samples to radiometrically date the late Pleistocene deposits. Radiocarbon ages previously reported for the site were inconsistent and primarily from bulk sediments; thus, only represent minimum ages. Third, to expose, record, and recover additional faunal remains and artifacts. The faunal analysis supported a paleoecological study to better understand the local environmental conditions during the late Pleistocene. In addition to new fieldwork at CHL, all previously excavated artifacts were reanalyzed to study the technologies and behaviors reflected in the assemblage.

Site Context

The CHL site is located along an erosional channel in a small, gently east-to-west sloping basin surrounded by rolling hills to the north, east, and south (Figure 4). While the site is located at the head of the channel today, historic aerial photographs indicate that the channel began at least 200 meters to the east. Ordovician limestone containing nodules of fine-grained cherts outcrop in the hills surrounding the drainage basin (Wilson and Miller 1963). The sediments containing the late-Pleistocene faunal remains

consist of fine-grained clays and gravels that have been redeposited through colluvial and alluvial processes from higher elevations in the basin and hills (Schmalle 2013).

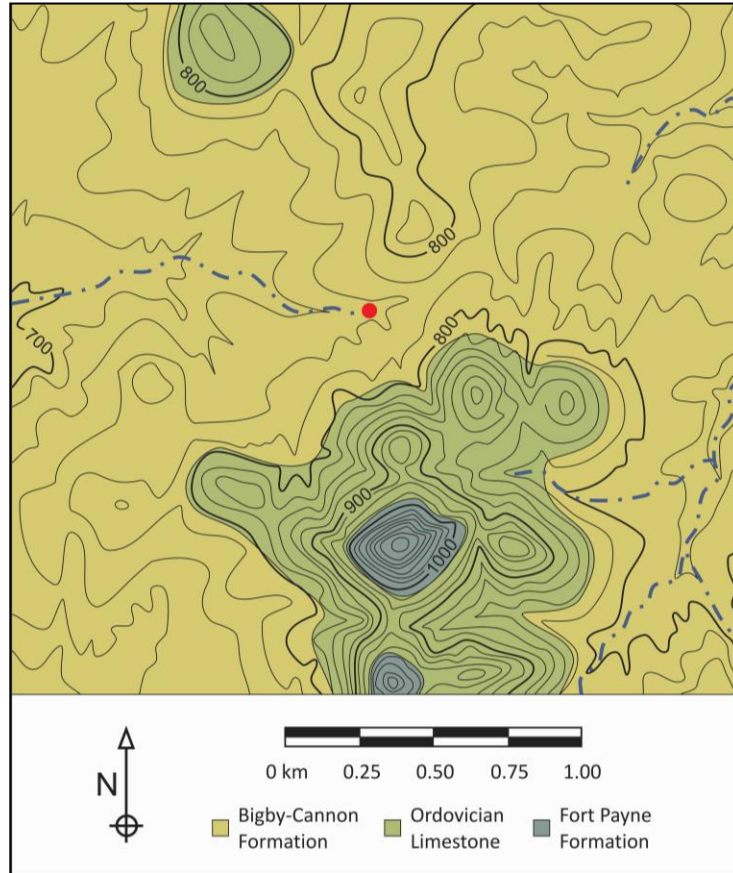


Figure 4. Location of the Coats-Hines-Litchy site relative to local geology.

Late Quaternary Stratigraphy

Breitburg and colleagues (1996) first described the stratigraphy and reported that the late Pleistocene faunal remains were in an old stream channel filled with rounded chert cobbles, quartz, and weathered siliceous gravels. Approximately 170 centimeters of Holocene sediments covered the late Pleistocene deposits in 1994-1995 (Breitburg et

al. 1996). A similar profile was recorded during the 2010 investigation (Deter-Wolf et al. 2011). However, between 1994-1995 and 2010 approximately 50-75 centimeters of fill was deposited on the site during the construction of a housing development (Deter-Wolf et al. 2011). Schmalle (2013) studied the late Quaternary stratigraphy and identified nine stratigraphic units exposed in the 2012 excavation block. Units 1 through 5 date to the late Pleistocene and are overlain by the Holocene sediments of Units 6 through 9.

Unit 1 is a strong brown (7.5YR 4/6) gravelly clay with secondary accumulations of illuvial clay, common redoximorphic features, and frequent accumulations of manganese and iron concretions with an abrupt, irregular boundary. Unit 2 is a gray (10YR 5/1) clay with secondary accumulations of illuvial clay, few redoximorphic features, and small manganese and iron concretions with an abrupt, irregular boundary. Unit 3 is a brown (7.5YR 4/2) silty clay with secondary accumulations of illuvial clay, common redoximorphic features, and manganese and iron concretions with an abrupt, irregular boundary. Small rodent borrows are present in the upper portion of Unit 3. Unit 4 is a dark grayish brown (10YR 4/2) silty clay with secondary accumulations of illuvial clay, and is heavily reduced with common manganese and iron concretions with an abrupt, smooth boundary. Unit 5 is a very dark grayish brown (10YR 3/2) silty clay, secondary accumulations of illuvial clay, common redoximorphic features, and accumulations of iron and manganese concretions with an abrupt, smooth boundary (Schmalle 2013).

Unit 6a-c was identified and defined near Area C, approximately 20 meters west of the 2012 excavation area, and stratigraphically post-dates Units 1-5. This unit consists

of poorly sorted, fining-upwards sands and gravels situated in an erosional channel. The lowest gravels of Unit 6 exhibit clast-supported imbrication, reflecting east-to-west stream flow. Unit 6 is not directly to the Area B excavations and is not discussed further (Schmalle 2013).

Unit 7a-c marks a dramatic change in depositional history at the site. This unit consists of a silty clay loam with faint secondary accumulations of clay films, faint redoximorphic features, minimal gravels and a smooth boundary. Pedogenic features documented in Unit 7c indicate a period of stability and soil formation. Units 8 and 9 represent relatively recent deposition over the last few hundred years. Unit 8 is a silty clay loam accumulated during historic agriculture practices, while Unit 9 consists of modern gravely-silt backfill deposited during recent land development (Schmalle 2013).

A pattern of deposition, stability, and erosion is indicated by the abrupt boundaries between Units 1 through 5. The low chroma and reduction of Units 2 through 4 indicate anaerobic conditions reflecting, at least intermittently, saturated sediments possibly in a swampy or ponded environment (which is also indicated by the following faunal analysis). Soft sediment deformation features are documented throughout Units 1 through 3. In some instances these turbation features are truncated by Unit 4, indicating a period of significant erosion. The visually distinct Unit 5 marks the uppermost late Pleistocene deposits and a period of extended stability and soil formation.

The gravely and silty clays of Units 1 through 5 consist of matrix supported, poorly sorted, colluvial gravels interfingered with alluvial silt and clay sediments. These colluvial sediments contain angular limestone and chert gravels lithologically similar to

the surrounding hills. Intermittent high-energy pulses of colluvial sediments containing gravel-size clasts were likely deposited during episodes of heavy rainfall. Plotting the vertical distribution of gravels indicates a visible spike in Units 2 and 3. The bone fragments are generally rounded and covered in scratches and gouges suggesting similar high-energy pulses also transported them. Heavily weathered and fragmented faunal remains occur throughout Units 1 through 3, while Unit 4 contains turtle carapace and plastron fragments. There is a very strong correlation between the vertical distribution of bone fragments and gravels ($r = 0.955$, $p = <0.001$) (Figure 5), further suggesting that similar, high-energy forces deposited both materials.

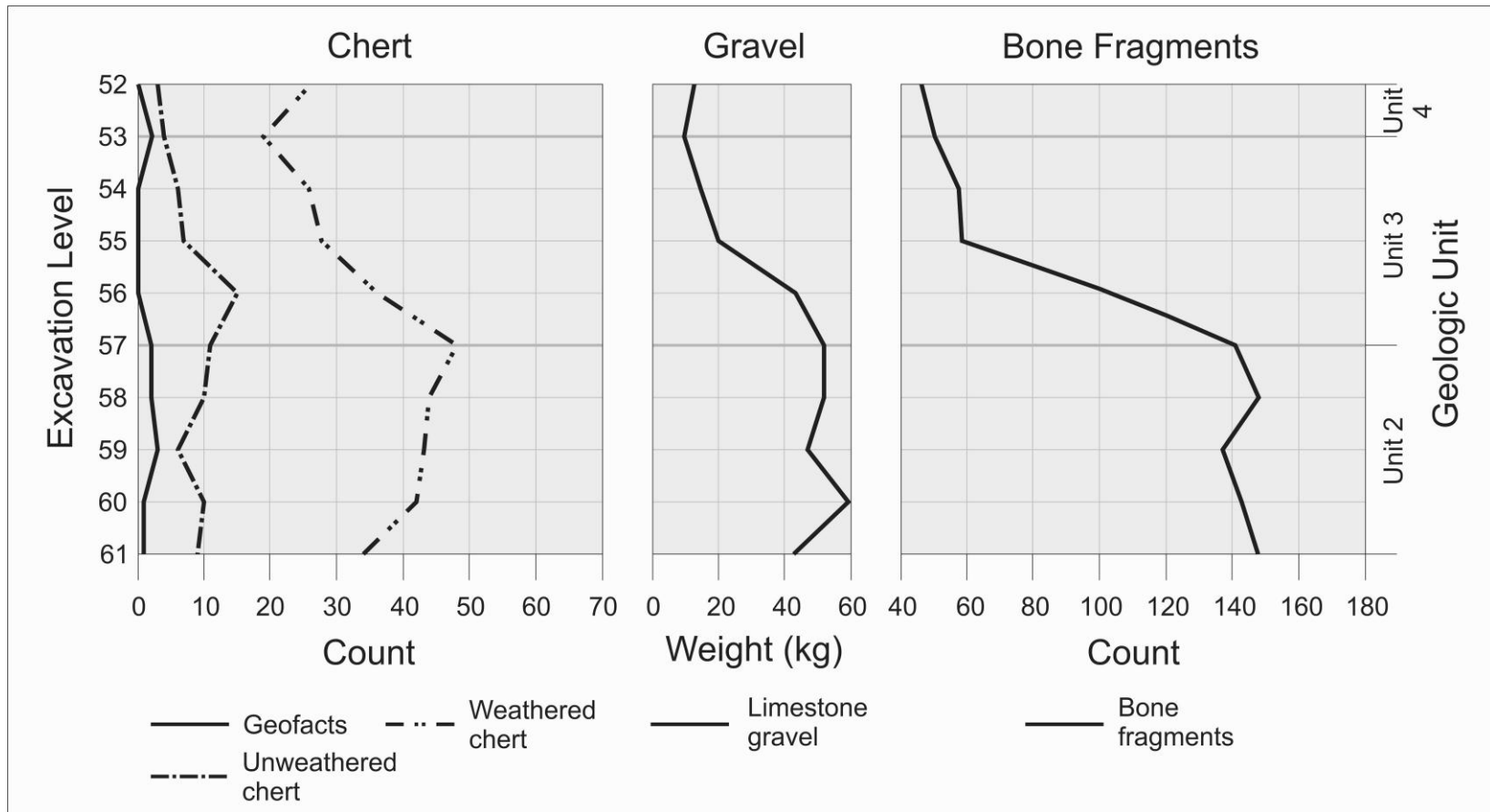


Figure 5. Vertical distribution of chert, gravel, and bone fragments from a sample of 12 units excavated in 2012.

Geochronology

All radiocarbon ages reported from CHL come from the lower sediments (Units 1-5) in Area B (Figure 6). Previous discussions of the radiocarbon record at CHL have included ages obtained from bulk sediment samples (Breitburg et al. 1996; Deter-Wolf et al. 2011). Organic sediments, however, are known to provide inaccurate ages and should not be taken to represent the actual age of the deposits (Bradley 2015). Only ages obtained from carbonized plant material are included here (Table 1). Such charcoal occurs as small pieces and dispersed throughout the sediments.

Three charcoal-based ages were reported from the 1994-1995 and 2010 excavations. Two ages of $27,050 \pm 200$ ^{14}C yr BP and $29,120 \pm 150$ ^{14}C yr BP are reported from the bone-bearing sediments (ca. Units 2-4) (Breitburg et al. 1996; Deter-Wolf et al. 2011). A third age of $12,300 \pm 60$ ^{14}C yr BP (Beta-288801) was obtained from a charcoal fragment above the bone-bearing deposit in 2010; however, the precise stratigraphic context of this sample is unclear.

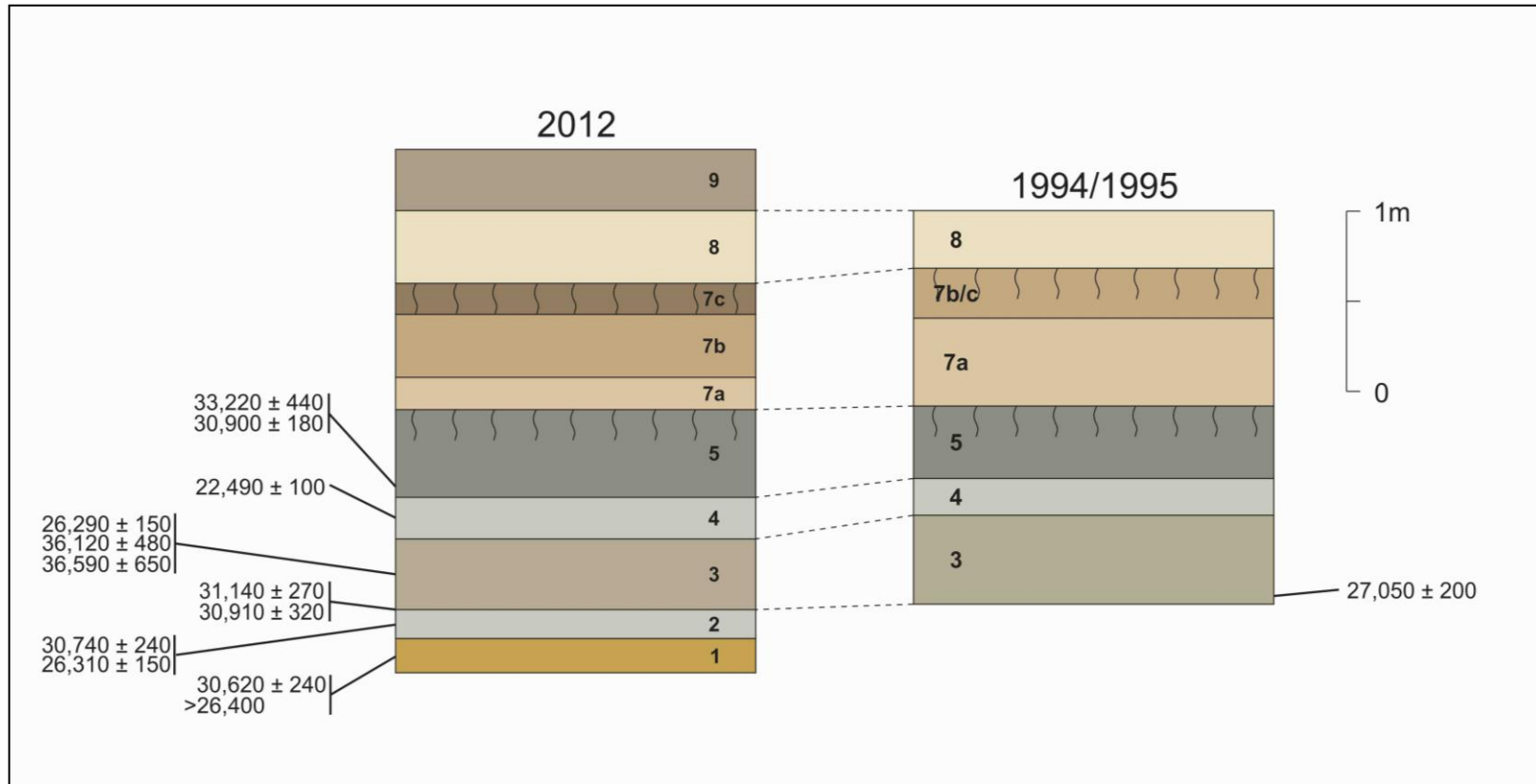


Figure 6. Generalized profiles from the Coats-Hines-Litchy site, Area B correlated with charcoal-based radiocarbon ages.

Table 1. All radiocarbon ages from the Coats-Hines-Litchy site.

<i>1994/1995 radiocarbon measurements from the Coats-Hines-Litchy site.</i>						
Laboratory Number	Northing/Easting	Elevation	Material Dated	Age ¹⁴ C yr B.P. (± 1 sigma)	Geologic Unit	Remarks
Beta-80169			Charcoal	27,050 \pm 200	Base of 3	Base of 1994
Beta-75403			Organic Sediment	6530 \pm 70	Unit 3	Within cusps of mastodon tooth
Beta-125351			Organic Sediment	10,260 \pm 240	Unit 3	Above mastodon humerus
Beta-125350			Organic Sediment	12,030 \pm 40	Unit 3	Below mastodon rib fragment
Beta-125352			Organic Sediment	14,750 \pm 220	Unit 3	Below mastodon humerus
<i>2010 radiocarbon measurements from the Coats-Hines-Litchy site.</i>						
Beta-288801		260 cmbs	Charcoal	*12,300 \pm 60	Units 2-4	Estimated provenience
Beta-288802		302 cmbs	Charcoal	29,120 \pm 150	Units 2-4	Estimated provenience
Beta-290990		289 cmbs	Organic Sediment	1960 \pm 30	Units 2-4	Estimated provenience
Beta-290991		290 cmbs	Organic Sediment	23,490 \pm 110	Units 2-4	Estimated provenience
<i>2012 radiocarbon measurements from the Coats-Hines-Litchy site.</i>						
UCIAMS-149780		215 cmbs	Charcoal	33,220 \pm 440	Base of Unit 5	From cutbank profile
UCIAMS-149781		200 cmbs	Charcoal	30,900 \pm 180	Base of Unit 5	From cutbank profile
UCIAMS-120329	N1000/E1010	98.000-97.950	Charcoal	22,490 \pm 100	Unit 4	From 2012 excavation
UCIAMS-120330	N998/E1008	97.900-97.850	Charcoal	26,290 \pm 150	Unit 3	From 2012 excavation
UCIAMS-120331	N1000/E1010	97.750-97.700	Charcoal	36,120 \pm 480	Unit 3	From 2012 excavation
UCIAMS-121950	N1000/E1010	97.750-97.700	Charcoal	36,590 \pm 650	Unit 3	From 2012 excavation
UCIAMS-120332	N999/E1005	97.650-97.600	Charcoal	31,140 \pm 270	Base of Unit 3	From 2012 excavation

(continued)

Table 1. (Continued)

UCIAMS-121951	N999/E1005	97.650-97.600	Charcoal	30,910 ± 320	Base of Unit 3	From 2012 excavation
UCIAMS-120333	N995/E1005	97.550-97.500	Charcoal	30,740 ± 240	Unit 2	From 2012 excavation
UCIAMS-120334	N1000/E1006	97.550-97.500	Charcoal	26,310 ± 150	Unit 2	From 2012 excavation
UCIAMS-120335	N1000/E1008	97.850-97.800	Charcoal	30,620 ± 240	Unit 1	From 2012 excavation
UCIAMS-120336	N996/E1007	97.400-97.350	Charcoal	>26,400	Unit 1	From 2012 excavation

*Previously this age was reported without the delta 13C correction as 12,050 ± 60 (Deter-Wolf et al. 2011).

In 2012 I obtained 12 new radiocarbon ages for the site. Two radiocarbon ages from Unit 1 date to $30,620 \pm 240$ ^{14}C yr BP (UCIAMS-120335) and $>26,400$ ^{14}C yr BP (UCIAMS-120336). Two ages from Unit 2 dates are $30,740 \pm 240$ ^{14}C yr BP (UCIAMS-120333) and $26,310 \pm 150$ ^{14}C yr BP (UCIAMS-120334). Ages of $31,140 \pm 270$ ^{14}C yr BP (UCIAMS-120332) and $30,910 \pm 320$ ^{14}C yr BP (UCIAMS-121951) were obtained from the base of Unit 3. Radiocarbon ages from Unit 3 are $26,290 \pm 150$ ^{14}C yr BP (UCIAMS-120330), $36,120 \pm 480$ ^{14}C yr BP (UCIAMS-120331), and $36,590 \pm 650$ ^{14}C yr BP (UCIAMS-121950). Unit 4 yielded a single age of $22,490 \pm 100$ ^{14}C yr BP (UCIAMS-120329). Two samples from the base of the Unit 5 paleosol were dated to $30,900 \pm 180$ ^{14}C yr BP (UCIAMS-149781) and $33,220 \pm 440$ ^{14}C yr BP (UCIAMS-149780). The radiocarbon ages show that geologic Units 1-5 predate the LGM. These ages align well with those reported from 1994-1995 and 2010.

The Oxidizable Carbon Ratio (OCR) method was previously used to determine the age of the deposits (Deter-Wolf et al. 2011). The OCR method is not a widely accepted dating technique and its veracity has been questioned (Killick et al. 1999). The

results of OCR dating remain equivocal and are not included here as reliable dates for the deposits.

Faunal Assemblage

The bonebed excavated in 1994-1995 was first recognized when fragments of mastodon vertebra, ribs, and tusks, and horse teeth were observed eroding out of the lower edge of the erosional channel. A series of excavations between May 1994 and March 1995 uncovered the partial remains of a disarticulated male mastodon (*Mammut americanum*). In addition to mastodon, the highly fragmented and partial remains of horse (*Equus* sp.), deer (*Odocoileus* sp.), muskrat (*Ondatra zibethicus*), canid (*Canis* sp.), turkey (*Meleagris gallopavo*), frog (*Rana* spp.), and painted turtle (*Chrysemys* cf. *picta*) were also recovered (Breitburg et al. 1996). While the specific locations of each specimen are unclear, horse teeth were recorded within and below the mastodon remains (Breitburg et al 1996; Deter-Wolf et al. 2011). Based on field records and photographic evidence, the mastodon remains recovered in 1994-1995 were in Unit 3 (Figure 7). Additional small bone fragments and turtle shell occur throughout Units 1-4.



Figure 7. Photograph of the mastodon bonebed in relation to the south and east profiles during the October 1994 excavation. Image courtesy of the Tennessee Division of Archaeology.

The overall faunal assemblage represents a highly fragmented and co-mingled deposit of multiple species. The bonebed consisted of a mixture of large identifiable elements intermixed with numerous small identifiable fragments. While there is no statistically significant orientation of bones ($X^2 = 4.9$; $df = 6$; $p = 0.56$), their fragmentary nature suggests post-depositional disturbances. Rounding and battering of the bone fragments suggests alluvial transportation.

Unlike the initial 1994-1995 excavations, excavations in 2010 and 2012 failed to identify any large, intact bones. During the 2010 excavation, 1,195 of the 1,582 bone fragments recovered were from 1/8 and 1/16 inch screens (Deter-Wolf et al. 2011). A total of 1122 bone fragments were recovered from excavation and 1/4 screening in 2012.

The remains recovered during the 2012 excavation were generally heavily weathered and highly fragmented, which prevented identification of most specimens. Turtle fragments were the most abundant specimens (*Chrysemus cf. picta*), greater than 95% of all identifiable fossil fragments (Table 2). However, fragmentary material was also collected from the American mastodon (*Mammot americanum*), including post-cranial elements and identifiable enamel fragments. Enamel fragments of horse teeth (*Equus* sp.), and deer antler (*Odocoileus* sp.) were also recovered. Most notably, the faunal list was expanded by one new taxon, a giant ground sloth (*Paramylodon* sp.) from the family Mylodontidae. Presence of the giant ground sloth is based on several tooth fragments, including a nearly complete caniniform (i.e., canine-like) tooth. While giant ground sloths have been found throughout Tennessee during the Pleistocene (Corgan and Breitburg, 1996), *Paramylodon* sp. (also known as *Glossotherium*) has only been documented from Guy Wilson Cave (Sullivan County, in eastern Tennessee) and Lock A (Davidson County, in central Tennessee).

Table 2. List of all identified animals recovered from the Coats-Hines-Litchy site.

Order	Family	Genus	Common Name
Proboscidea	Mammutidae	<i>Mammot americanum</i>	American mastodon
Xenarthra	Mylodontidae	<i>Paramylodon</i> sp.	Giant ground sloth
Perissodactyla	Equidae	<i>Equus</i> sp.	Horse
Artiodactyla	Cervidae	<i>Odocoileus</i> sp.	Deer
Rodentia	Cricetidae	<i>Ondatra zibethicus</i>	Muskrat
Carnivora	Canidae	<i>Canis</i> sp.	Canid
Galiliformes	Phasianidae	<i>Meleagris gallopavo</i>	Turkey
Anura	Ranidae	<i>Rana</i> spp.	Frog
Testudines	Emydidae	<i>Chrysemys cf. picta</i>	Painted turtle

Of all the faunal material examined from the site, only the mastodon remains have been suggested to provide evidence of human interaction. Breitburg and colleagues (1996; Breitburg and Broster 1995) reported cutmarks on a thoracic vertebra based on an apparent V-shaped cross-section of the linear incision. Other researchers have questioned this interpretation (Cannon and Meltzer 2004; Grayson and Meltzer 2015; Haynes and Hutson 2014). It is unclear how the purported cutmarks were identified as such from the numerous scratches present on the specimen in question (Cannon and Meltzer 2004:1970). While a detailed study of the purported cutmarks has not been published, some information can be gleaned from photographic evidence. The marks in question consist of three incisions of varying depth, and from approximately one to four cm in length. Natural processes have been demonstrated to produce linear, V-shaped incisions on bones (Haynes and Krasinski 2010; Krasinski 2010). Trampling is known to produce linear incisions visually similar to the CHL specimen, specifically in coarse-grained sediments (Haynes 2012:102, Figure 7). Thus, the presence of incisions alone does not unequivocally prove humans modified the bones.

The CHL faunal assemblage most likely represents a secondary accumulation of disarticulated and fragmentary remains of many animals. The high-energy pulses likely further fragmented the bones in the process of redepositing them. As such, angular gravels frequently occurring in the bone-bearing sediments could have easily produced linear, V-shaped incisions on the bones. Furthermore, the fragmentary nature of the bonebed and presence of linear incisions also suggest post-depositional disturbance.

The faunal assemblage provides information related to the local paleoecological setting and indicates a water-edge environment existed at or near CHL. Specifically, the presence of the painted turtle, various frog species, and muskrat reflect a well-watered, mesic woodland environment. Painted turtles are widespread in North America; however, they rely on fresh water and often prefer densely vegetated waters with limited flow (Ernst and Lovich 2009). The presence of muskrat (*Ondatra zibethicus*) reflects the existence of a well-watered environment at or near CHL. Muskrats are a semi-aquatic mammal commonly found in relatively shallow, slow moving lentic environments with an abundance of hydrophytic vegetation (Nadeau et al. 1995). It is also significant to note that muskrats are large burrowing rodents (Messier et al. 1990), as this may relate to some post-depositional disturbances at CHL.

Geochemical Analysis of Faunal Remains

Geochemical analysis of the late Pleistocene faunal remains was conducted to further investigate the contextual association between the faunal remains excavated in 1994-1995 and those in 2012. Bone from the mastodon excavated in 1994-1995 and mastodon and turtle excavated in 2012 was sampled for Rare Earth Element (REE) analysis. Approximately 5-10 mg of cortical bone or turtle carapace was removed using a Dremel™ rotary drill with carbide burs. The sample powders were placed in clean Savillex™ vials, and dissolved overnight on a hot plate with 3ml of 8M HNO₃. After dissolution, samples were opened and dried on the hotplate. Four ml of 0.8M HNO₃,

spiked with 8 ppb Re, was added to the samples by weight to re-dissolve the dry residue. A small aliquot of the resultant solution was removed and diluted with additional 0.8M HNO₃, spiked with 8 ppb Re, so that the final dilution was around 2,000x. The final dilution for trace element analyses was determined by weight for each sample. REE analyses were performed on a Thermo Finnigan ELEMENT2 Inductively Coupled Plasma Mass Spectrometer (ICP-MS) in the Department of Geological Sciences at the University of Florida. All measurements were performed in medium resolution with Re used as internal standards. Quantification of results was done by external calibration using a set of gravimetrically prepared REE standards. All REE concentrations were normalized to PAAS (Post-Archean Australian Shale; McLennan 1989). The REEs analyzed, range from La (Z = 57) to Lu (Z = 71) (Table 3). I excluded europium (Eu)

Table 3. Rare Earth Element concentrations for faunal specimens used in geochemical analysis. (Values normalized to PAAS; McClellan 1989).

	Turtle (T416)	Turtle (T676)	Mastodon (M329)	Mastodon (M625)	Mastodon (M653)	Mastodon (M1994)	Mastodon (M382)
La	0.16027	0.15988	0.11674	0.07142	0.08203	0.03359	0.03564
Ce	0.31160	0.27535	0.14202	0.07938	0.08548	0.03056	0.03059
Pr	0.54292	0.47212	0.28552	0.10354	0.12800	0.04314	0.03537
Nd	1.00527	0.83452	0.44905	0.14745	0.17961	0.05422	0.03656
Sm	1.94692	1.55609	0.83642	0.23891	0.28375	0.08440	0.04655
Gd	4.54027	3.63612	1.73420	0.55093	0.54989	0.15672	0.07309
Tb	4.53085	3.65774	1.77478	0.55311	0.53173	0.15884	0.07081
Dy	5.62099	4.54613	2.23483	0.69014	0.62093	0.16667	0.06681
Ho	6.03568	4.93664	2.50059	0.81056	0.68017	0.19200	0.08718
Er	6.36066	5.21062	2.69280	0.88482	0.71718	0.19174	0.07717
Tm	5.82522	4.76949	2.61999	0.85716	0.68537	0.19673	0.08991
Yb	5.04259	4.11984	2.42742	0.75793	0.59391	0.15597	0.08310
Lu	5.00032	4.12001	2.52471	0.80677	0.62617	0.16031	0.06826

from the analysis *post hoc*, due to anomalous Eu enrichment and depletion spikes (see DeSantis and Wallace 2008; Trueman et al. 2004).

REEs occur in very low concentrations (ppb or less) in bones of living animals, however after death, the REEs are rapidly taken up from the local burial environment in the skeletal material (e.g., Trueman et al. 2004). Therefore, the REE patterns of fossil bones reflect their diagenetic environments and studies have shown that bones fossilized in different geochemical environments can be distinguished based on their REE patterns (e.g. MacFadden et al. 2007; Trueman 1999). The REE analysis of the samples allowed for a comparison of patterns of REEs obtained post-mortem. Normalized REE patterns from the mastodon humerus collected in 1994-1995 are similar to, and closely parallel, those of turtle shell and mastodon bones collected in 2012, despite differences in concentrations of REEs (Figure 8). Similar REE patterns reflect comparable depositional environments (Trueman 1999; MacFadden et al. 2007). While the sediments and faunal materials at CHL are in secondary fluvial/colluvial deposits, the similar REE patterns indicate that the animals died and were buried in close proximity to one another or exposed to pore water with similar chemistry. The similar REE patterns of the faunal samples, therefore, reaffirm the stratigraphic correlations between the excavations. In addition to REE analysis, stable isotope analyses were conducted to assess the diets of fauna from CHL. Specifically, ~1-2 mg of enamel powder was sampled from tooth enamel and tooth dentin (from ivory) of *Mammot americanum*, *Equus* sp., and tooth dentin was sampled from *Paramylodon* sp. One bulk sample, parallel to the growth axis of the tooth, was sampled on all teeth. Five serial samples were also drilled of *Mammot*

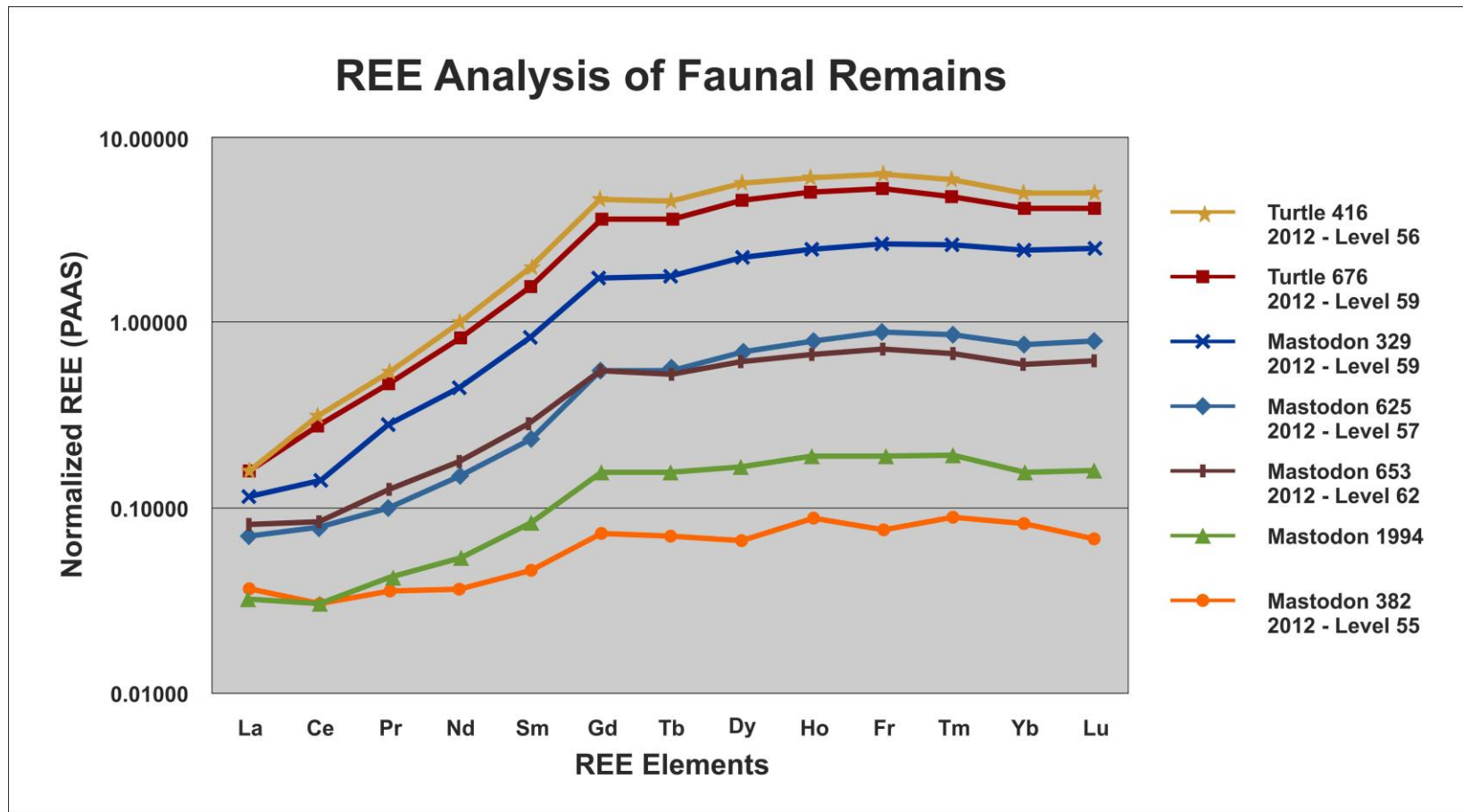


Figure 8. Rare earth element (REE – normalized to post-Archean Australian Shale; McClellan 1989) data for *Mammot americanum* and *Chrysemys cf. picta* from the Coats-Hines-Litchy site.

americanum, each were sequentially located along the tooth's growth axis (with individual samples drilled perpendicular to the growth axis of the tooth). All samples were chemically treated with 30% hydrogen peroxide for 24 hours and 0.1 N acetic acid for 18 hours to remove organics and secondary carbonates, respectively (Koch et al. 1997; similar to DeSantis et al. 2009). Approximately 1 mg of these samples were then run on a Finnigan-MAT 252 isotope ratio mass spectrometer coupled with a Kiel III carbonate preparation device in the Department of Geological Sciences at the University of Florida. The analytical precision is $\pm 0.1\%$, based on replicate analyses of samples and standards (NBS-19). Stable isotope data were normalized to NBS-19 and are reported in conventional delta (δ) notation for carbon ($\delta^{13}\text{C}$), where $\delta^{13}\text{C}$ (parts per mil, ‰) = $((R_{\text{sample}}/R_{\text{standard}})-1)*1000$, and $R = {}^{13}\text{C}/{}^{12}\text{C}$; and the standard is VPDB (Pee Dee Belemnite, Vienna Convention; Coplen 1994). All stable isotopes are from the carbonate portion of enamel, dentin, or bone hydroxyapatite.

All isotopic results are reported in and Table 4. Taking into account the ${}^{13}\text{C}$ enrichment from food to tooth enamel and dentin ($\sim 14\%$), as well as the decline in $\delta^{13}\text{C}$ values ($\sim 1.5\%$) of atmospheric CO_2 due to fossil fuel burning over the past two centuries (Cerling and Harris 1999; DeNiro and Epstein 1978; Friedli et al. 1986), carbon isotope values less than $\sim 8\%$ indicate a diet consisting of primarily C_3 vegetation whereas $\delta^{13}\text{C}$ values of greater than -2% indicate a diet of predominantly C_4 vegetation (Cerling and Harris 1999; Cerling et al. 1997). Lower $\delta^{13}\text{C}$ values can also indicate the consumption of browse in denser canopied C_3 forests (Cerling et al. 2004; DeSantis and Wallace 2008; van der Merwe and Medina 1989, 1991). All $\delta^{13}\text{C}$ values from all

mammals sampled are consistent with the consumption of C₃ vegetation. The mean $\delta^{13}\text{C}$ enamel value for the morphologically inferred browser *M. americanum* (Haynes 1991; n

Table 4. Bulk carbon isotopes mammalian taxa from the Coats-Hines-Litchy site.

Taxon	Element	$\delta^{13}\text{C}$
<i>Mammut americanum</i>	tooth fragment - sample A	-10.9
<i>Mammut americanum</i>	tooth fragment - sample A	-9.9
<i>Mammut americanum</i>	tooth fragment - sample A	-10.6
<i>Mammut americanum</i>	tooth fragment - sample A	-12.1
<i>Mammut americanum</i>	tooth fragment - sample A	-10.9
<i>Mammut americanum</i>	tooth fragment - sample A	-11.7
<i>Mammut americanum</i>	tooth dentin (ivory)	-9.2
<i>Equus</i> sp.	tooth fragment	-9.4
<i>Paramylodon</i> sp.	caniform tooth	-10.1
<i>Paramylodon</i> sp.	tooth fragment	-10.2
<i>Paramylodon</i> sp.	tooth fragment	-7.0
<i>Paramylodon</i> sp.	tooth fragment	-8.4

= 5, from one tooth fragment) is -11.0‰ (+/- 0.8 standard deviation; n = 5) is consistent with C₃ vegetation within a forest or woodland environment. Further, these values are highly consistent and range from -12.1 to -9.9‰, a total range of 2.2‰. Similarly, *Equus* sp. has a $\delta^{13}\text{C}$ enamel values of -9.4‰, also indicative of a predominately C₃ diet; however, these resources may have been C₃ grasses as *Equus* is largely interpreted as a grazer throughout much of its range during the Pleistocene (MacFadden 2005). *Paramylodon* sp. has a mean $\delta^{13}\text{C}$ dentin value of -8.9‰ (+/- 1.5 standard deviation; total range of 3.2‰, between -10.2 and -7‰; n = 4 tooth fragments). While all of these tooth fragments may have come from one individual, they may represent different times in the individual's life during which the teeth were mineralizing. While further work is

needed to assess if these teeth have been diagenetically altered, as dentin is more prone to diagenesis than enamel (Wang et al. 1994), preliminary analysis of the REEs of sloth dentin from the Pleistocene suggest that carbon isotope values from apatite may yield biologically meaningful results (MacFadden et al. 2010).

Artifact Assemblage and Context

The CHL assemblage consists of 145 specimens, including 38 from the 1994-1995 excavation and 11 from the 2010 excavation (Figures 9 and 10). The 1995-1995 assemblage includes 42 flakes and flake fragments, two graters, one fire-cracked chert fragment, one blocky scraper, one biface fragment, and two osseous artifacts. An additional 13 flakes and 83 pieces of angular chert shatter were recovered in 2012 (Figure 11). Breitburg and colleagues (1996) documented 12 lithic specimens *in situ* within the bonebed deposit. The remaining specimens were recovered out of context or during subsequent processing of bulk sediment samples. All lithic specimens from CHL are either Fort Payne or Bigby-Cannon chert, which is readily available throughout the region and outcrops immediately above the site. Additional lithic artifacts and faunal material has been occasionally recovered from the erosional channel, including a large biface fragment, unidirectional core, and a mineralized antler fragment (Deter-Wolf et al. 2011). Extensive lithic assemblages have also been recovered from three Archaic and Woodland surface sites within 200 m upslope of CHL. Only lithics directly related to Area B of CHL are discussed in detail here.

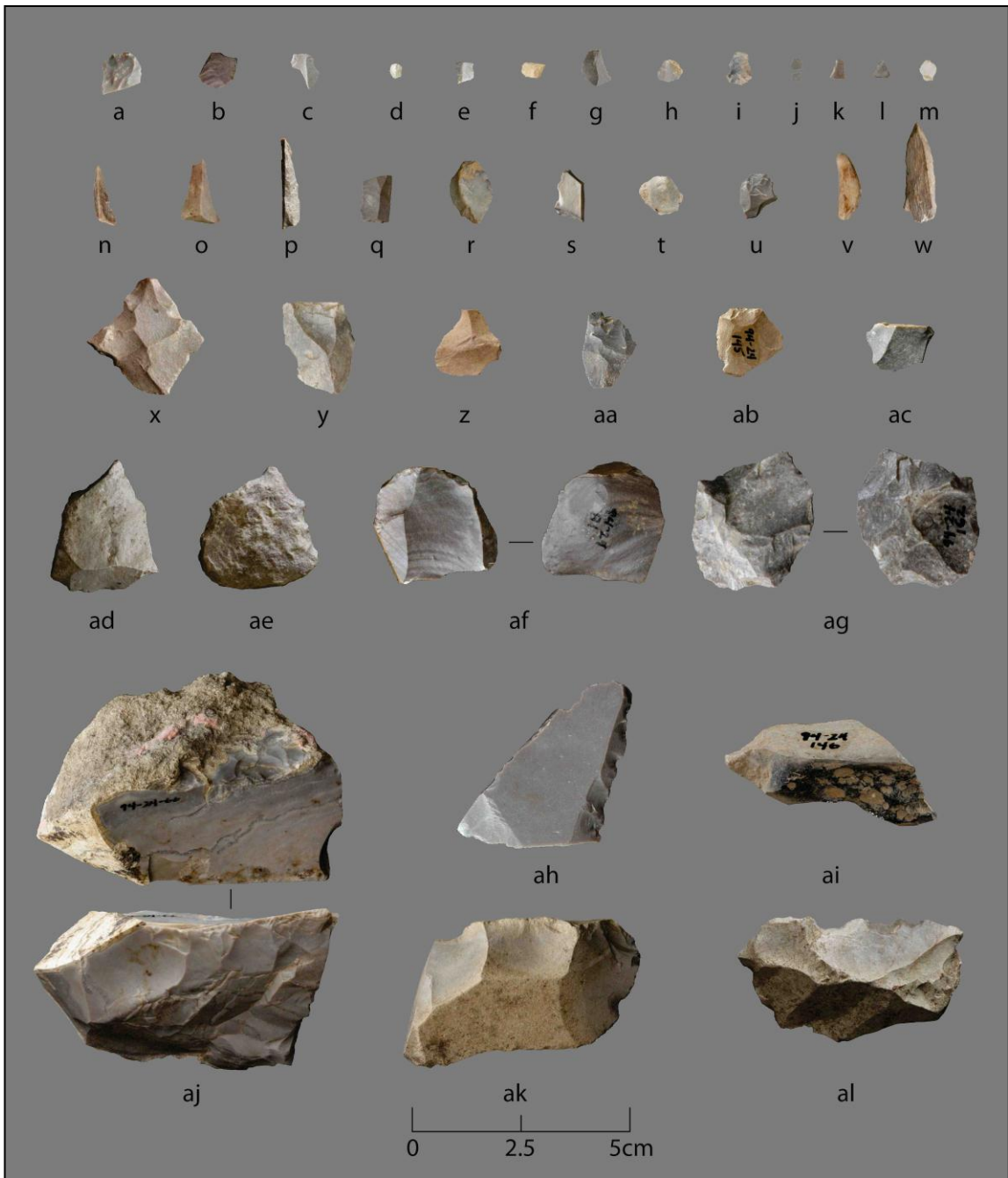


Figure 9. All lithic specimens recovered during the 1994-1995 excavations at the Coats-Hines-Litchy site.

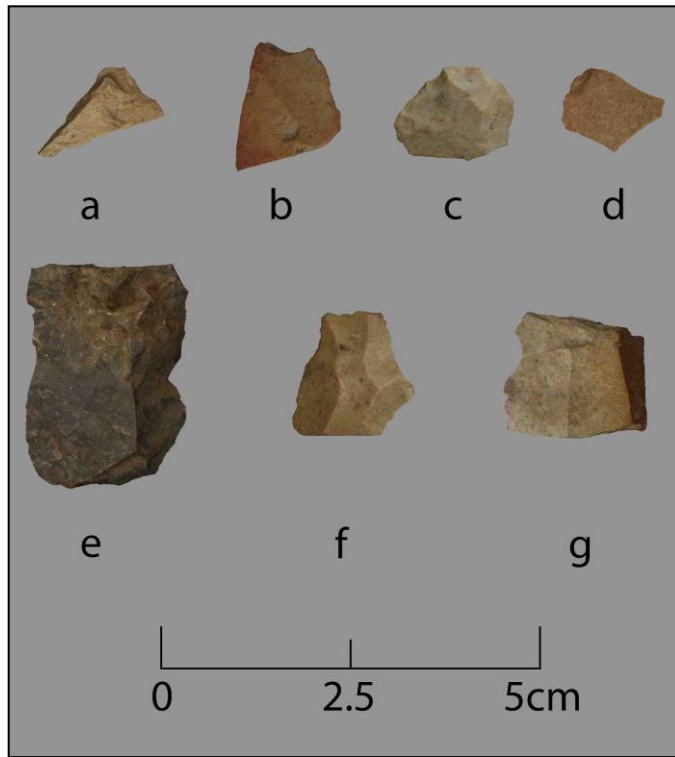


Figure 10. Selected lithic specimens recovered from the 2010 excavation at the Coats-Hines-Litchy site.

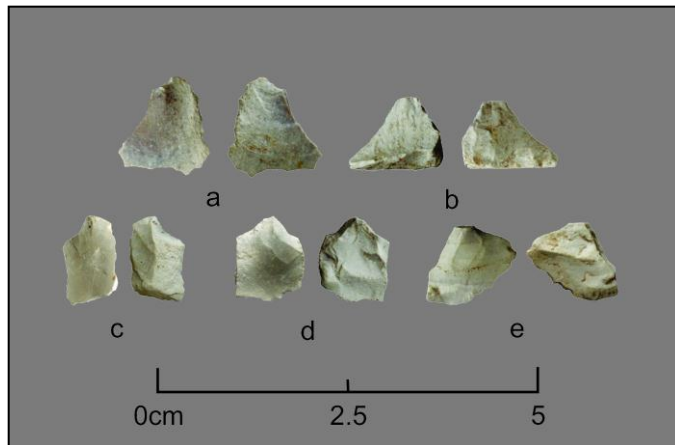


Figure 11. Selected lithic specimens recovered from the 2012 excavation at the Coats-Hines-Litchy site.

Upon reanalysis, the two reported osseous specimens do not appear to be culturally-produced artifacts. The specimen previously described as a pressure flaker is a 15.1 mm long fragment of antler (Figure 9v). The specimen is heavily worn, but lacks visible evidence of usewear. The potential bone point is a splintered fragment of bone with three flat, angular sides (Figure 9w). Like the antler fragment, there is no unequivocal evidence of intentional modification. Furthermore, this specimen does not possess any morphological similarities to known osseous points from other archaeological contexts. As such, both specimens appear to be naturally-produced.

The thermally fractured angular shatter from 1994-1995 (Figure 9ai) has one patinated and two cortical surfaces, while the remaining two surfaces are covered in distinctive potlid fractures. Two pieces of small fragments (< 20 mm) of angular shatter recovered in 2012 also exhibit potlid fractures from heating. Because natural fires can produce potlid fractures in cryptocrystalline material, in the absence of additional evidence, these specimens are all interpreted as naturally-produced. The remaining 79 pieces of angular shatter from 2012 are unpatinated, angular fragments ranging from 37.5 to 3.32 mm in size. None of the additional shatter exhibits any evidence of cultural modification.

The large, angular scraper (Figure 9aj) has two cortical surfaces, one unpatinated flat surface, and one surface with a series of erratic angular fractures. There is a series of systematic, unifacial flake removals along one margin. The unpatinated fractures and systematic flake scars appear to be culturally-produced. However, this specimen was

recovered after it had eroded out into the drainage; thus, direct association with the bonebed cannot be verified.

Upon reanalysis, the two specimens reported to be gravers are actually naturally-produced chert fragments. While one specimen (Figure 9ad) has three large flat facets on the dorsal surface, there is no systematic pattern to the flaking that may indicate intentional shaping. The other specimen (Figure 9ae) does not possess any facets from flake removals and both faces are covered in weathered, bumpy natural cortex. What would be the bit portions of both specimens lack any evidence of micro chipping or usewear that would have occurred through use.

Arguably the most significant artifact from CHL is the biface fragment (Figure 9ag). While there is no question that this is a culturally-produced artifact, its provenience is questionable. The biface was recovered from the area of the bonebed initially excavated in May 1994 (Figure 12). However, the biface was not actually discovered until the third stage of excavation in March 1995. At that time the area where it was discovered had already been excavated and the bones removed. As such, the location where the biface was recovered was exposed for approximately 10 months in the bottom of the erosional drainage before its discovery. That being said, the association of the biface to the bone-bearing deposits cannot be unequivocally determined.

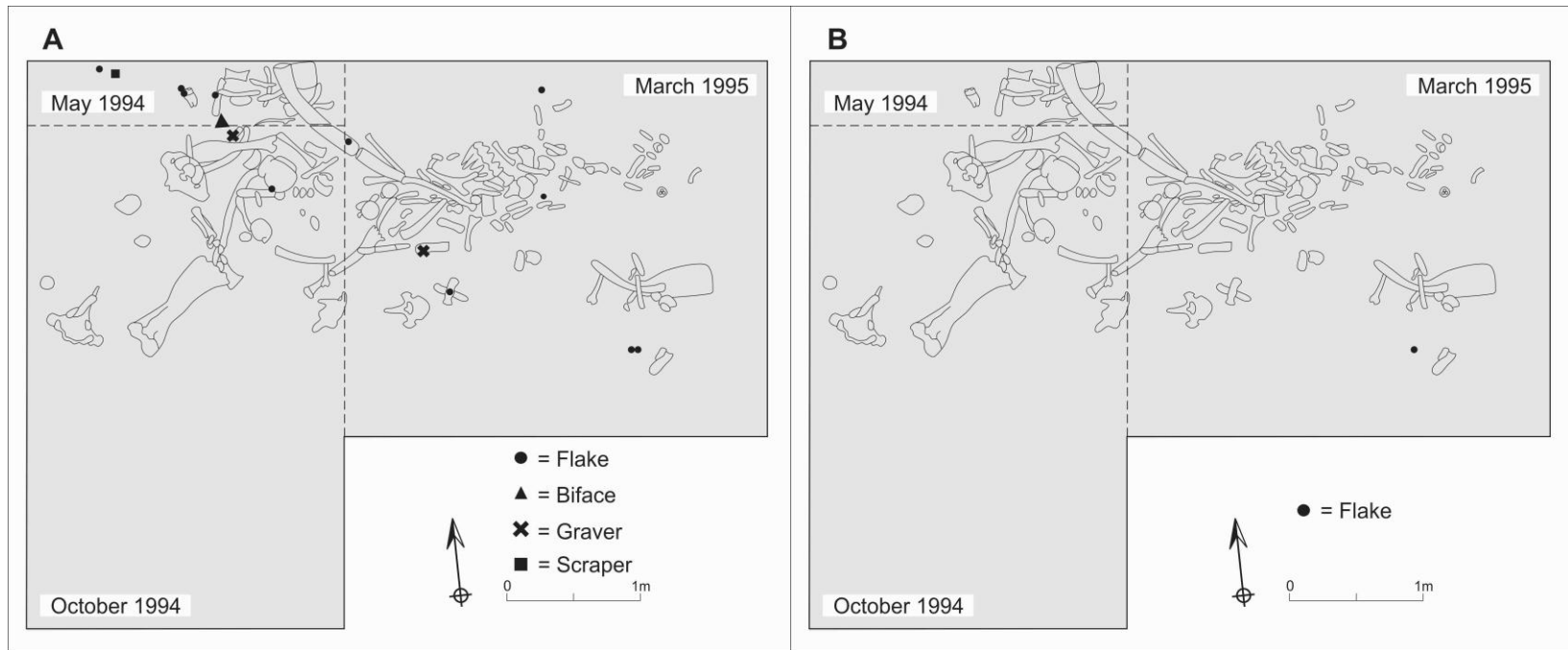


Figure 12. Planview of Area B bonebed from 1994-1995 excavations with locations of lithic specimens. A) Lithic specimens previously reported *in situ*. B) Lithic specimens with unequivocal provenience. Image adapted from Breitburg et al. 1996, Figure 1.

Fifty-two flakes and flake fragments have been recovered from CHL, including 19 pieces of microdebitage (smaller than 1.25 cm), 9 flake fragments lacking striking platforms, and 24 flakes with striking platforms. One flake fragment has systematic, unifacial flaking suggestive of intentional cultural modification (Figure 9ah). However, it must be noted that while this specimen has previously been attributed to the bone-bearing deposits at CHL, the artifact was actually recovered from a different archaeological site. Sequential accession numbers associated with the two sites, and the fact that they were both excavated at the same time, likely contributed to the error. Additionally, 13 flakes lack unequivocal association with the bone-bearing deposits and were either recovered after they eroded out into the drainage, or were recovered in general bulk sediment samples. Thus, only 17 macrodebitage specimens, 12 flakes and 5 flake fragments, have verifiable provenience from all excavations at CHL.

All flakes smaller than 1.25 cm (microflakes) were deemed as too small to conclusively discern specific attributes (King 2012; Lubinski et al. 2014; Waters et al. 2011a). As such, only macro-flakes are described here based on morphological and technological attributes. The macrodebitage has overall similar morphology (Table 5). All specimens have relatively small average width (14.21 mm) and length (14.18 mm), with a width:length ratio of 1.02. The average thickness (4.35 mm) and weight (0.96 g) are slightly skewed because of to two outliers (specimens 491-2 and 94-24-81). Technological attributes were studied by scoring each flake based on the presence or absence of specific attributes (Lubinski et al. 2014; Peacock 1991; Staley 2006; Wisniewski et al. 2014). The assemblage is dominated by flat, non-cortical platforms;

however, two specimens exhibit faceted platforms (Table 6). Half of the specimens have erailure scars, but only four exhibit distinct bulbs of percussion. Four specimens have more than three dorsal scars, but only one has flake scars demonstrating directional orientation. Two specimens appear to have negative bulbs of percussion on their dorsal sides, and three complete lack dorsal cortex.

Table 5. Metric attribute data of macroflakes and macroflake fragments from the Coats-Hines-Litchy site.

Specimen	Type	Length (mm)	Width (mm)	Thickness (mm)	Weight (g)	W:L
652	flake	16.5	17.1	5.8	1.31	1.04
630	flake	10.4	13.2	2.5	0.30	1.27
530	flake	15.0	18.1	3.4	0.67	1.21
424	flake	11.7	13.5	2.5	0.40	1.15
491-2	flake	18.0	23.7	10.5	2.96	1.32
203	flake	11.8	10.0	5.2	0.49	0.85
459	flake	10.5	13.7	2.9	0.32	1.30
514	flake	12.2	7.4	2.8	0.24	0.61
357	flake	9.6	13.0	4.7	0.38	1.35
182	flake	13.6	12.5	2.0	0.31	0.92
538	flake	11.8	10.2	2.1	0.28	0.86
94-24-81	flake	24.3	27.4	5.9	4.51	1.13
415	fragment	23.1	15.7	7.5	1.99	0.68
510	fragment	11.5	12.7	4.7	0.63	1.10
248	fragment	10.7	13.1	2.7	0.34	1.22
94-24-150	fragment	15.9	10.7	4.0	0.68	0.67
94-24-151	fragment	14.5	9.5	4.7	0.48	0.66
Average		14.18	14.21	4.35	0.96	1.02
Max.		24.30	27.40	10.50	4.51	1.35
Min.		9.60	7.40	2.00	0.24	0.61

Table 6. Lithic attribute scores for macroflakes from the Coats-Hines-Litchy site (1 = attribute present, 0 = attribute absent).

Specimen Number	Faceted Platform	Non-Cortical Platform	Bulb of Percussion	Erailure Scar	3+ Dorsal Flake Scars	Flake Scar Orientation	Negative Dorsal Bulb	Absence of Dorsal Cortex	Total
94-24-81	0	0	1	1	1	0	1	0	4
FS#530	0	1	0	0	0	0	0	0	1
FS#652	0	0	1	0	0	0	0	0	1
FS#357	0	1	0	0	0	0	0	0	1
FS#203	0	1	1	0	0	0	0	0	2
FS#630	1	1	0	0	0	0	0	0	2
FS#491-2	0	1	0	0	1	0	1	0	3
FS#424	0	1	0	1	0	0	0	1	3
FS#538	0	1	0	1	0	0	0	1	3
FS#182	0	1	0	1	0	0	0	1	3
FS#459	0	1	1	1	1	0	0	0	4
FS#514	1	1	0	1	1	1	0	0	5
Total Attribute Score (%)	2 (16.67%)	10 (83.33%)	4 (33.33%)	6 (50.00%)	4 (33.33%)	1 (8.33%)	2 (16.67%)	3 (25.00%)	

There appears to be no discernable pattern to the distribution of flakes and flake fragments recovered from the site. The 2012 assemblage was dispersed vertically throughout geologic Units 2, and 3, which generally correspond to excavation levels 52-61 (Figure 5). While the sample of flakes and flake fragments is exceptionally small and generally evenly distributed, the highest frequency ($n = 7$) of specimens occurs in levels 57-59.

Experimental studies have demonstrated that the composition and coarseness of the sediment matrix is directly associated with site formation processes related to fragmentation of lithic assemblages (Andrefsky 2013; Pevny 2012; Rasic 2004). A sample of 12 excavation units from the 2012 excavation was used to study the coarse sediment matrix in geologic Units 2 and 3. A total of 351.89 kg of angular limestone gravel was recovered from the 12 excavation units. The 12 excavation units contained a total of 346 pieces of chert weighing 4.78 kg. Of that, 81 pieces are unweathered angular debris that are classified as chert shatter. While the distribution of chert and gravel indicates higher energy transport of sediments, it also reflects important site formation issues related to sediment composition.

Lithologically, all of the chert found in the sediment matrix is comparable to the immediately local geology surrounding CHL. All chert in the sediment matrix is either Fort Payne or Bigby-Cannon. Likewise, all of the specimens in both lithic assemblages are either Fort Payne or Bigby-Cannon. The bedrock formation at CHL is comprised of Bigby-Cannon Limestone Formation, which is a medium to coarse-grained limestone with cryptocrystalline chert nodules (Wilson and Miller 1963). The hills forming an

upland environment immediately surrounding the site consist of Fort Payne Limestone (Wilson and Miller 1963), which is well-known as a chert-rich formation (Amick 1987; Parish 2013).

The lack of formal tools associated with the bonebed, absence of intentional modification to flakes, and no discernable occupation surface lead us to interpret the lithic assemblage contextually associated with the bonebed is naturally-produced. The few specimens that could be interpreted as culturally-produced flakes are inconsistent with flake distributions found at archaeological sites. All specimens exhibit exceptionally similar morphology. It appears that all specimens were produced through uniform force and hard-hammer percussion. This interpretation is further supported by the composition of the sediment matrix, geomorphic setting, and energy regime. The high-energy depositional environment containing an abundant chert gravel fraction led to the creation of an intriguing geofact assemblage in association with redeposited faunal remains. While unequivocal formal tools and lithic debitage were found in close proximity to the bonebed, an evaluation of excavation records and photographs indicates these materials were redeposited from surrounding archaeological sites.

Patterns in Pre-LGM-age Sites

Similar patterns are beginning to emerge at proposed pre-LGM-age sites throughout North America. Discerning culturally-produced artifacts from naturally fractured stone is straightforward when large, diverse lithic assemblages exist. However,

small assemblages of informal or unmodified flakes are problematic, such as at Burnham, Oklahoma (Wyckoff et al. 2003), the Wenas Creek Mammoth site, Washington (Lubinski et al. 2014), and Coats-Hines-Litchy. Fluvial settings where periodic high-energy pulses move significant amounts of chert-rich sediments are especially prone to redepositing cultural and natural materials of various ages. The Burnham site, Oklahoma, provides particularly relevant comparison to CHL. At Burnham the partial remains of extinct bison and other late Pleistocene animals were recovered in general association with lithic flakes and chert shatter from a ca. 35,000-36,000 cal yr BP deposit. In addition to flakes and flake fragments, a crude bifacially flaked specimen and chert cobble were also recovered. However, a close inspection of flake scars along the unbroken margin of the biface “seem to suggest post-breakage damage and the possibility that some of the other flakes scars are fortuitous or natural, and that the fragment is not really a man-made biface at all” Buehler 2003:223). Likewise, the cobble does not exhibit unequivocal evidence of intentional flaking (Buehler 2003:225).

Extensive research indicates that the majority of lithic material was recovered from pond sediments (Wyckoff and Carter 2003). However, as at CHL, there is a significant spike in gravel frequency that directly corresponds to the vertical distribution lithic flakes (Buehler 2003, Figure 16.59). While coarse-grain sediments and gravel clasts reflect high-energy events, they also provide abundant lithic materials that can naturally produce flakes. As such, geomorphic processes must be considered when interpreting the taphonomy of small lithic flake assemblages.

In addition to distribution, patterns in flake morphology are also evident in the CHL and Burnham assemblages (Figure 13). Of the 51 flakes and flake fragments at Burnham, 4 (8%) are macrodebitage, while 47 (92%) are microdebitage. All of the macro-flakes are either distal or medial fragments. Macrodebitage averages 15.26 mm in width and 14.66 mm in length, with a width:length ratio of 1.8. While the flakes at Burnham are predominately microdebitage, the overall assemblage size and morphology is exceptionally comparable to CHL.

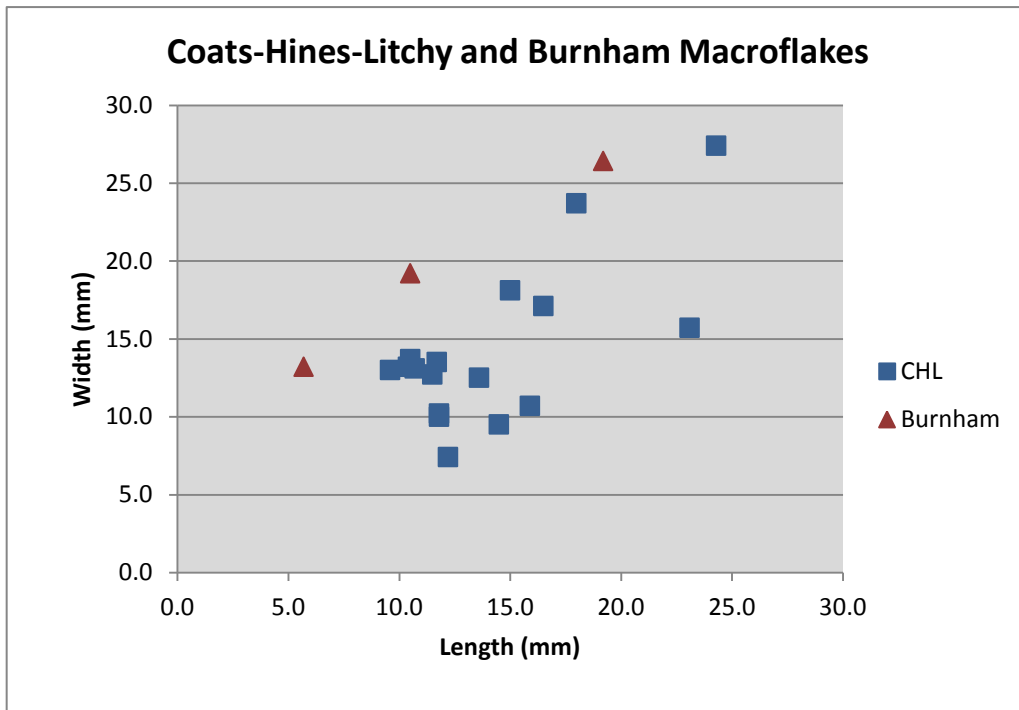


Figure 13. Comparison of macroflakes from the Coats-Hines-Litchy (Tennessee) and Burnham (Oklahoma) sites.

Artifact-like geofact assemblages are also known from locations where cryptocrystalline materials and high-energy regimes coexist. Examples include chert

outcrops eroding along steep gradients (e.g., Topper, SC), or mass wasting colluvial deposits containing toolstone quality materials (e.g., Wenas Creek, WA). During high-energy colluvial events in such environments, collisions between lithic materials can conceivably create natural flakes with artifact-like attributes.

Discussion

Context and site formation are critical factors when interpreting archaeological sites, especially Pleistocene-aged lithic assemblages (Andrefsky 2013; Waters 2004). Depositional factors influencing the creation of naturally-produced lithic assemblages have been documented at numerous Pleistocene-age sites (Gillespie et al. 2004; King 2012; Lubinski et al. 2014; Waters et al. 2009; Wisniewski et al. 2014). Experiential studies of artifact taphonomy demonstrate the effects of sediment composition on lithic assemblages (e.g., Andrefsky 2013; Eren et al. 2011; Pevny 2012; Rasic 2004).

Many of the earliest sites in the Americas are located on, or adjacent to, sources of chert-bearing deposits (Andrefsky 2013). As such, the ability of high-energy environments to naturally produce lithic assemblages, reminiscent of culturally-produced artifacts, should be carefully considered when interpreting archaeological sites. Because toolstone is typically chosen based on its ability to fracture predictively, the same fracture patterns can occur by natural or cultural processes (Andrefsky 2013). Essentially, due to fracture mechanics, cryptocrystalline material will break in similar ways whether influenced by humans or by nature (Cotterell and Kamminga 1987). As

such, I must rely on overall patterns of assemblages to effectively interpret them as being naturally or culturally produced (Patterson 1983). This issue is paramount when addressing contentious pre-Clovis sites that hinge upon a relatively small lithic assemblage comprised of flakes and flake fragments. The lithic assemblages from CHL and Burnham exemplify this issue.

Increased research into, and scrutiny of, late Pleistocene sites has driven both field research and theory alike. Part of the theoretical advancement of the field has come in the form of increased understanding of site formation processes (e.g., Schiffer 1983; Stein 2001). Geoarchaeology has been at the forefront of this advancement due in large part to the unique problems associated with late Pleistocene-age sites (Waters 1992, 2004). This growing body of research has identified multiple geomorphic settings capable of producing sites with certain archeological characteristics, albeit lacking contextual integrity or culturally-produced artifact assemblages. When CHL is compared to other proposed pre-LGM-age sites, a pattern begins to emerge. Environments with sufficient geomorphological energy regimes and naturally occurring cryptocrystalline materials warrant extra caution when evaluating the archaeological integrity of sites.

Conclusion

To address outstanding questions regarding the association of lithic artifacts and extinct megafauna, as well as the context and age of the deposits, at the Coats-Hines-Litchy site, I conducted a comprehensive, multidisciplinary investigation. Our evaluation

of the site is based on a large-scale excavation and analyses of new and existing data sets. A suite of 14 radiocarbon ages obtained on charcoal, demonstrate the late Pleistocene sediments containing the faunal and lithic assemblages are at least 22,000 ^{14}C yr BP (26,000 cal yr BP).

The highly fragmentary and battered nature of the faunal assemblage, in addition to the geoarchaeological study of the sediments, indicate that the materials were redeposited in an erosional channel composed of course-grained colluvial and alluvial sediments. The sediment matrix containing the partial remains of numerous late Pleistocene fauna also contains substantial quantities of locally abundant cherts and limestone. The high-energy geomorphic environment, in conjunction with the natural sediment matrix, further fragmented the faunal remains, while also producing patterns of linear grooves on the bones.

Culturally and naturally-produced lithic materials were recovered from the CHL site. Culturally-produced lithic artifacts from nearby Holocene-aged archaeological sites were redeposited in an erosional channel where late Pleistocene faunal materials were exposed. The culturally-produced artifacts were subsequently recovered in close proximity to late Pleistocene faunal remains. Physical weathering resulting in rock fracture at the outcrop combined with high-energy colluvial and alluvial processes appear to have fractured naturally occurring chert resulting in flakes and angular shatter with artifact-like attributes. These geofacts were identified and excavated in direct association with the faunal materials. While these results may be unsettling for some,

this is an intellectually honest assessment of site formation and assemblage context at the CHL site.

Other pre-LGM-age sites throughout North America have produced similar lithic assemblages (e.g., Burnham, OK, Wenas Mammoth Creek, WA, and Topper, SC). A comparison of the geomorphic environments of these sites based on published literature suggests a similar pattern of site formation processes. High-energy geomorphic settings are known to produce complex assemblages, often containing culturally and naturally-produced lithic and faunal materials. These scenarios are exacerbated when cryptocrystalline material naturally occurs in abundance and constitutes significant portions of the sediment matrix. The implications associated with pre-LGM-age sites require a critical and cautious approach to be taken when interpreting assemblages, geochronology, and site context.

Ultimately, individual archaeological sites do not exist in a vacuum. That is to say, as part of a larger structure of cultural systems, every site must inherently fit within known patterns of human occupation. Thus, pushing back the date of human arrival in the Western Hemisphere requires replicable evidence and a related framework of sites sharing technological and cultural similarities, not just a single site, or sporadic occurrence of unrelated sites.

CHAPTER III
CHARACTERIZING CUMBERLAND FLUTED BIFACE MORPHOLOGY AND
TECHNOLOGICAL ORGANIZATION

Introduction

Despite the importance of Cumberland fluted technology in the early human occupation of eastern North America, questions remain regarding its production, use, and timing. Cumberland technology is frequently referenced in discussions of Paleoindian chronologies (Anderson and Sassaman 2012; Anderson et al. 2010; 2015; Broster et al. 2013; Driskell et al. 2012; O'Brien et al. 2001, 2014) and potential YD human adaptations (Anderson et al. 2011; Meeks and Anderson 2012). Of all Paleoindian technologies in North America, however, Cumberland is one of the least understood. While there is an extensive body of literature devoted to understanding other fluted biface technologies (e.g., Amick 1999; Bradley et al. 2010; Gingerich 2013; Waters et al. 2011b), research related to Cumberland has been extremely limited. Nearly all previous studies of Cumberland technology were conducted on datasets of fewer than 20 specimens. Thus, until there is a thorough understanding of what Cumberland *is*, discussions related to technological organization, chronological association with other biface types, and potential YD behavioral adaptations, remain speculative.

Cumberland fluted bifaces represent the instrument-assisted fluted horizon in the North American Midsouth, and are assumed to be generally contemporaneous with the

beginning of the YD (Anderson 2004; Anderson and Sassaman 1996; Anderson et al. 2010, 2015; Bradley et al. 2008; Broster et al. 2013; Ellis and Deller 1997; Fiedel 1999; Goodyear 1999; Meeks and Anderson 2012; Meltzer 2009; Tankersley 1990, 1996). While these bifaces are prevalent throughout the Midsouth, they have only been recovered from surface or disturbed contexts (Anderson et al. 2010; Anderson et al. 2011; Goodyear 1999). Jolly's (1972) study comparing Cumberland and Clovis fluted biface technology in the Middle Tennessee River Valley, though 30 years old, is still the most detailed discussion of the Cumberland biface production sequence. However, the small sample size (n = 14) provides limited support for his interpretation of Cumberland technology. Although Bell (1960) states the Cumberland toolkit consists of various unifacial tools, there are no known discrete Cumberland assemblages.

The overall objective of this study is to identify, and offer potential explanations for, variability within Cumberland technology. The research presented here is the first to comprehensively address the question, "What is Cumberland?" from the perspective of technological organization, and incorporates previous studies of geographic distribution and chronology with new morphological and technological data. One way to link lithic artifacts to behavioral adaptations is to reconstruct how hunter-gatherers organized their lithic technologies (Binford 1979; Kuhn 1995; Shott 1986; Torrence 1983). Investigating how technologies were organized causes us to view technology as a set of behaviors related to human adaptation rather than a set of objects related to a production procedure (Nelson 1991). How bifaces were made, hafted, used, refurbished, and discarded offer valuable insight into how Cumberland technology was organized (Kuhn, 1995; Nelson,

1991). The *life histories*, as it were, of Cumberland bifaces are used to support inferences about behavioral adaptations in the Midsouth during the late Pleistocene (Binford 1979; Nelson 1991).

Geographic Distribution

Unlike most other diagnostic point types, there is not a type-site for Cumberland fluted-bifaces. Rather, the genesis of Cumberland as a type is derived from the dense concentration of bifaces recovered along the Cumberland River in middle Tennessee during the early twentieth century. Lewis (1954) coined the name *Cumberland* to describe a large, thick lanceolate fluted-biface similar to Clovis found throughout the Cumberland River Valley. The core geographic distribution of Cumberland encompasses much of the area between the Tennessee and Ohio Rivers (Figure 14) (Anderson et al. 2010; Justice 1987). The conflation of typological names may explain the identification of some Cumberland-like bifaces across a larger territory (see Bradley et al. 2010; Justice 1987; White 2006). Notably, the Midsouth is also characterized by an abundance of high-quality cherts (Amick 1987; Parish 2011, 2013). The Fort Payne and St. Louis formations range from northern Alabama to central Kentucky, and contain tabular and cobble forms of various chert varieties.

Data available in PIDBA and state surveys suggest that people using Cumberland fluted bifaces had a predilection for major river valleys in the Midsouth, similar to Clovis (Anderson 2004; Anderson et al. 2010; Barker and Broster 1996; Breitburg and

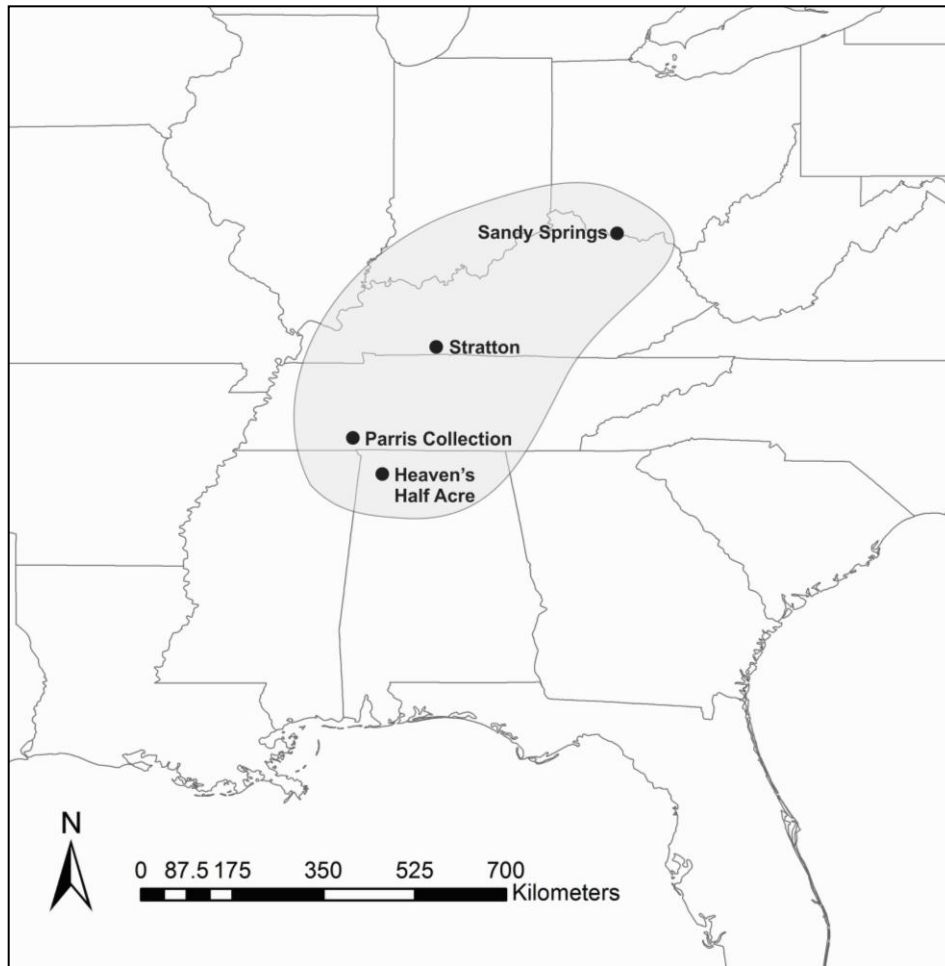


Figure 14. Generalized core distribution of Cumberland fluted bifaces and sites discussed in text.

Broster 1994; Broster and Norton 1996). Based on Clovis data, Miller (2011) suggests that rather than sampling or population biases, the distribution of fluted bifaces reflects a land-use strategy focused on the intersection of rivers, physiographic boundaries, and toolstone sources. It is reasonable to assume this pattern holds true for Cumberland as well. However, there is a conspicuous absence of Cumberland bifaces at most large quarry sites in the region, suggesting that a restructuring of technological organization

coincided with the development of Cumberland technology (Anderson et al. 2011). Precisely what that restructuring was, though, currently remains unknown.

Though Cumberland bifaces are dispersed throughout most of the Midsouth, relatively high densities have been documented in specific areas that may represent aggregation or habitual-use locations. The Sandy Springs site, in southern Ohio, is near the northern extent of Cumberland distribution and is located in close proximity to a saline spring (Seeman et al. 1994; Tankersley 1994). At least 15 Cumberland bifaces have been documented from Sandy Springs, and may represent a regional aggregation location (Seeman and Prufer 1982; Seeman et al. 1994; Tankersley 1989). There is limited evidence for on-site biface reduction and a high percentage of finished bifaces made from non-local raw materials (Aagesen 2006; Seeman et al. 1994).

The Parris Collection and Heaven's Half Acre represent important locations near the southern extent of Cumberland distribution. The Parris Collection primarily comes from multiple sites in Hardin County, in south-central Tennessee (Tune et al. 2015). Extensive research by avocational archaeologist Jim Parris identified a series of fluted biface sites concentrated on remnant levees of the Tennessee River. Heaven's Half Acre represents a series of fluted biface sites near the Tennessee River in northern Alabama. Since the 1950s avocational archaeologists have recovered large numbers of Cumberland and other fluted biface forms from the margins of geomorphic depressions that may have been wet season ponds during the late Pleistocene (Futato 1996; King 2007). The Parris Collection and Heaven's Half Acre assemblage are characterized by

impact damage and basal fragments made on locally available raw materials, and likely reflect discard behaviors and possibly toolkit maintenance activities.

Chronological Considerations

Buried and datable Paleoindian sites are notoriously rare in the Midsouth (e.g., Miller and Gingerich 2007). At this time Cumberland bifaces have been recovered from surface contexts and palimpsest components containing multiple biface types. This situation has prevented Cumberland from being directly dated. Technological similarities to other well-dated, and presumably coeval, biface forms in adjacent regions, and stratigraphic chronologies in the Midsouth support a post-Clovis chronology. Based on widely accepted technological chronology, the emergence of instrument-assisted fluted technologies post-date Clovis and generally corresponds to the beginning of the YD (Anderson et al. 2015; Anderson et al. 2010; Bradley et al. 2008; Ellis and Deller 1997; Fiedel 1999; Goodyear 1999, 2010; Meltzer 2009; Tankersley 1990, 1996). Folsom fluted technology has been securely dated throughout the Plains and Southwest to 10,700-10,390 ^{14}C yr BP (12,680-12,260 cal yr BP) (Frison and Stanford 1982; Hill 2001; Hill and Hofman 1997; Hofman 1995; Meltzer 2006), and corresponds well with the expected range of Cumberland in the Midsouth.

Assuming Clovis immediately precedes instrument-assisted fluting in the Midsouth, as it does in other regions, then it is possible to establish a maximum age for Cumberland. Relying on charcoal-based radiocarbon ages, the age of Clovis in the

greater Midsouth matches that of other regions and ranges from $10,980 \pm 75$ to $10,915 \pm 30$ ^{14}C yr BP ($12,860 \pm 90$ to $12,760 \pm 30$ cal yr BP) (Brose 1994; Goodyear 2013; McAvoy and McAvoy 1997; Waters et al. 2009). Therefore, Cumberland is assumed to occur after ca. 12,800 cal yr BP.

Cumberland bifaces (as well as Quad, Beaver Lake, and Dalton) were recovered from the lowest cultural deposits of Dust Cave, northern Alabama (Driskell 1994, 1996; Sherwood et al. 2004). A heavily reworked Cumberland biface and a Cumberland-like distal biface fragment were recovered from the basal components (Driskell 1994, 1996; Hollenbach and Walker 2010; Sherwood et al. 2004). The precise stratigraphic sequence of the Paleoindian bifaces at Dust Cave is unclear, as multiple types co-occur within the same deposits. Dalton, however, generally occurs above other Paleoindian forms (Driskell et al. 2012; Sherwood et al. 2004), and thus, may provide a minimum age for Cumberland. Eight radiocarbon ages on dispersed charcoal in the lowest Quad/Beaver Lake/Dalton component (Zone U) range from $10,500 \pm 60$ to $10,310 \pm 60$ ^{14}C yr BP ($12,430 \pm 120$ to $12,140 \pm 140$ cal yr BP) (Sherwood et al. 2004). As such, ca. 12,100 cal yr BP may represent the end of Cumberland.

The Phil Stratton site, in Kentucky, has been presented as an intact Cumberland site dating older than 14,000 cal yr BP (Gramly 2008, 2009, 2012, 2013, 2015). However, reanalysis of the existing assemblage and new excavations have documented significant contextual problems with the assemblage and proposed dates (Tune and Melton 2013). Of the 42 identifiable bifaces, only six are Cumberland. The remaining 36 are Archaic, Woodland, and Mississippian. Based on the diagnostic biface assemblage,

the Phil Stratton site does not represent a pure Cumberland site. Rather, the site appears to have been extensively re-occupied beginning in the late Pleistocene and continuing throughout the entire Holocene.

In 2013 the site was excavated to study the stratigraphy and potentially recover additional artifacts (Figure 15). The 2013 excavation units were placed immediately

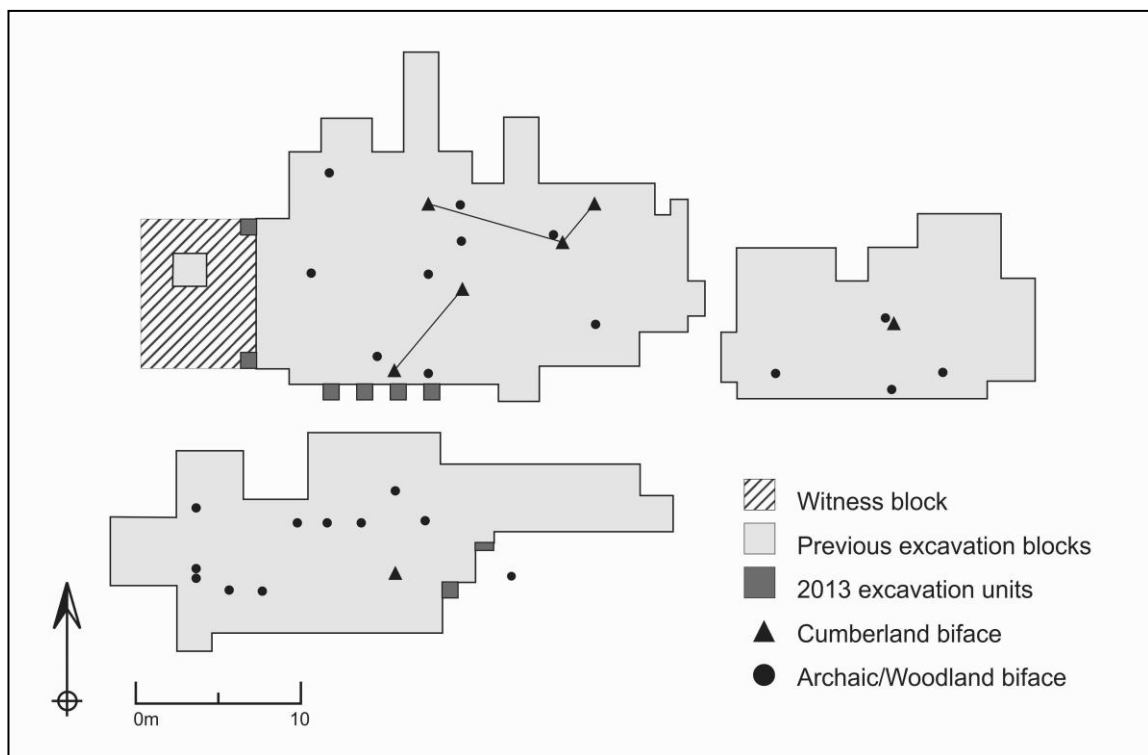


Figure 15. Phil Stratton site excavation blocks and distribution of identifiable bifaces. Adapted from Gramly 2013.

adjacent to the previous excavation blocks to correlate the geologic profiles and evaluate previous interpretations of the site. Two units were specifically placed adjacent to a “witness section that was set aside for future investigators” (Gramly 2013:143). The

2013 excavation documented shallow, deflated deposits that are extensively disturbed by tree roots, bioturbation, and agricultural processes.

Two geologic units were recorded in 2013 at the southern-most edge of the site where deposition is greatest (Figure 16). The upper Unit 2 (0-25 cm) is a brown (10YR

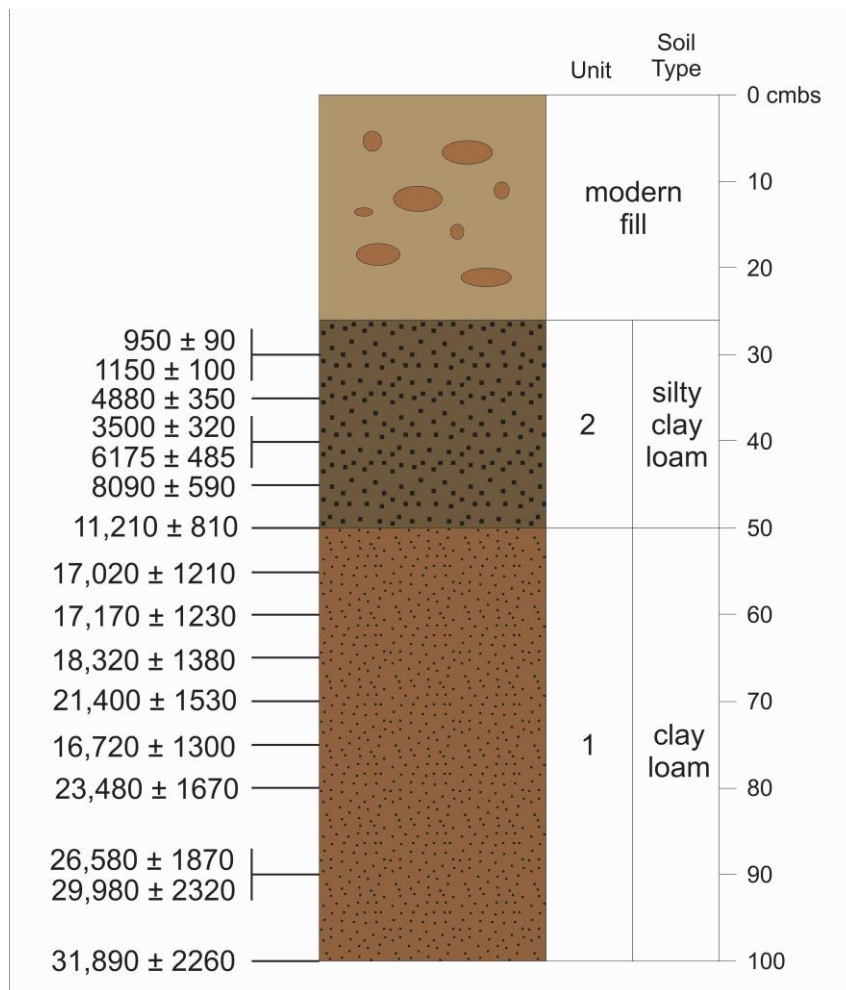


Figure 16. Generalized profile of the Phil Stratton site with the relative depths of OSL ages reported by Gramly (2013) correlated with the stratigraphic profile documented in the 2013 excavation.

4/4) silty clay loam with subangular blocky structure, few small roots, abundant iron manganese accumulations, and an abrupt wavy boundary. Unit 2 is composed of eolian sediments redeposited from the erosion of the upper hill slope. The lower Unit 1 (25+ cm) is an oxidized brown clay loam (7.5YR 4/6) with few iron manganese accumulations, common bioturbation features, and an abrupt (erosional), wavy boundary. Unit 1 represents a clay residuum formed from the weathering of the limestone bedrock and is commonly exposed throughout the surrounding area due to erosion by intensive agricultural practices. In some areas of the site Unit 2 is covered by up to 25 cm of recently redeposited fill consisting of a mixture of both Units 1 and 2. Artifacts are deposited throughout Unit 2, and occasionally intrude into Unit 1 through root molds and animal burrows. Artifacts are also present in the redeposited overburden.

Gramly (2012) contends the Cumberland occupation at the Phil Stratton site predates 14,000 cal yr BP based on a series of optically stimulated luminescence (OSL) dates. A critical review of the published literature, however, clearly indicates that such early dates do not correlate with the artifact-bearing deposits (Figure 16). As such, a calibration curve was constructed to correlate the OSL ages with the artifact-bearing deposit (Gramly 2013, 2015). The OSL calibration curve is based on two unsupported assumptions. First, the modern ground surface at the Phil Stratton site is assumed to be equivalent in age to the end of Peoria Loess deposition, or 12,800 cal yr BP (Gramly 2013, 2015). The end of Peoria Loess deposition has been well-studied throughout the Central Plains and Midwest and is dated to 16,000-12,000 cal yr BP (Bettis et al. 2003; Johnson and Willey 2000; May and Holen 2003; Muhs et al. 1999, 2001, 2008). Second,

such a calibration also assumes a constant rate of deposition has occurred without any erosional episodes. However, the Phil Stratton site is located on a highly eroded landform that has been subjected to intense agricultural plowing since the early nineteenth century (Phil Stratton personal communication). Moreover, a major unconformity representing another episode of erosion is clearly visible at the contact of geologic Units 1 and 2. Thus, the variable rate of deposition and erosion, as well as the unsupported age of the ground surface refute any interpretations drawn from the OSL calibration curve for the Phil Stratton site.

Furthermore, the OSL ages likely represent pedogenesis rather than the timing of deposition because pedogenic processes mix grains of various ages (Bateman et al. 2007a, 2007b). Pedogenesis is known to compromise the results of OSL dating, specifically in upland geomorphic settings with thick, weathered argillic horizons (Ahr et al. 2013), such as at Phil Stratton. Ahr and colleagues studied the effects of pedogenesis in sandy sediments of upland sites in Texas and found that “pedogenic mixing of particles of various apparent ages, and... changes in environmental dose rate due to weathering” skewed the ages of those samples (Ahr et al. 2013:221). As a result, the OSL ages represent “apparent age estimates rather than true depositional ages” (Ahr et al. 2013:14). Because Phil Stratton is in a similar geomorphic setting, and similar pedogenic processes have affected the sediments, the OSL ages there also likely reflect pedogenesis rather than deposition. Thus, at this time the OSL ages from Phil Stratton do not provide an accurate age of Cumberland occupation.

Datasets and Methods

To identify and interpret variability in Cumberland technology, over 900 Cumberland fluted bifaces were examined. While it is very likely that fluted and unfluted Cumberland bifaces were part of the same technological system, the lack of context and typological similarities to other late Pleistocene biface forms (e.g., Beaver Lake), preclude the analysis of unfluted specimens in this study. In time fluted and unfluted Cumberland bifaces may be recognized as part of the same technological system that also includes Beaver Lake, similar to Folsom and Midland bifaces (Amick 1995; Hofman 1992; Jennings 2012; Meltzer 2006). Primary data collected from collections throughout the Tennessee and Ohio River Watersheds, as well as corresponding data from PIDBA, were analyzed to study quantitative and qualitative attributes of Cumberland biface morphology (Table 7). In turn, this was used to study technological elements related to artifact life histories. Assessing biface production, use, reuse, and discard, facilitates interpretations of technological organization and may help explain variability (Andrefsky 2010). Finally, inferences about settlement strategies were made based on the organization of technological elements.

While intact and dateable late Pleistocene archaeological sites are rare in the Midsouth, exceptional fluted biface survey data has been compiled (Anderson 2004; Anderson et al. 2010; Goodyear 1999; Miller and Gingerich 2013). Potential biases and limitations are known for PIDBA datasets and include incomplete data, sample inconsistency, site formation processes, ground cover (see Anderson et al. 2010 and

Table 7. Cumberland collections included in analyses.

Collection	Number of Specimens	Curation Location	Collection Provenience
Discovery Park of America	9	Union City, Tennessee	Tennessee Tennessee, Alabama,
Guerra Collection	15	Terre Haute, Indiana	Kentucky, Ohio
King Collection	88	Cullman, Alabama	Alabama
Parris Collection	39	Savannah, Tennessee	Tennessee
Indian Mound Museum	12	Florence, Alabama	Alabama
Tennessee Division of Archaeology	13	Pinson, Tennessee	Tennessee
Smithsonian National Museum of Natural History	21	Washington DC	Tennessee, Alabama, Kentucky
Stratton Collection	9	Adairville, Kentucky	Kentucky
Tennessee State Museum	9	Nashville, Tennessee	Tennessee
PIDBA, Tennessee	314		Tennessee
PIDBA, Alabama	377		Alabama

Prasciunas 2011 for a detailed discussion of biases). Given these limitations, PIDBA datasets are still widely accepted to model human behaviors (Anderson and Gillam 2000; Anderson et al. 2011; Lanata et al. 2008; Meeks and Anderson 2012; Miller 2011; Shott 2013; Smallwood 2012; Smallwood et al. 2015).

Methods for Characterizing Morphology

Assessing biface morphology is a productive way to identify and document the range of variability within biface technologies. The morphological study presented here is based on primarily analysis of 216 finished Cumberland fluted bifaces (Table 8). An additional 695 finished Cumberland bifaces documented in PIDBA for the study area

were also studied. All maximum measurements and morphological ratios used in this study are documented only on complete specimens. Basal width, waist width, depth of basal concavity, and depth of basal concavity-to-basal width are documented from basal fragments and complete specimens.

Table 8. Cumberland bifaces included in analyses.

Condition	Primary	PIDBA		Total
		Tennessee	Alabama	
Complete	85	206	104	395
Base	76	59	155	290
Midsection/Distal	27	28	108	163
Miscellaneous Fragments	0	16	6	22
Preforms	28	5	4	37
Total	216	314	377	907

I characterize Cumberland biface morphology using a standard set of metric variables and morphological ratios (Eren et al. 2011; Jennings 2013; Morrow and Morrow 1999; Smallwood 2012; Thulman 2006). For each finished biface, I recorded the maximum length, maximum width, maximum thickness, basal width, waist width, face-angle, and flute length and width (when possible), inner flute thickness, depth of basal concavity, weight, presence/absence edge grinding, and blank form (when possible). I calculated morphological ratios such as length-to-width, width-to-thickness, depth of basal concavity-to-basal width, and lateral indentation index (LII) for each biface. Presumably the most standardized attributes reflect the elements most critical to the overall technological system. As such, I calculated a coefficient of variation (CV) for all attributes as a way to measure relative standardization (Eerkens and Bettinger 2001).

Coefficient of variation provides a statistical technique to assess standardization between samples by comparing standard deviation to the mean (Eerkens and Bettinger 2001). The smaller a CV value is, the more standardized a sample is.

Methods for Studying Technological Organization

To understand how Cumberland bifaces were made, used, reworked, and discarded I recorded flaking pattern, basal grinding, thermal alteration, fluting elements, and post-fluting reduction, as well as patterns in fracture types, reworking, and abandonment. These attributes reflect elements of provisioning strategies as they are related to organization (Pitblado 2003). I analyze 28 previously undocumented preforms, in addition to studying nine documented in PIDBA, and 15 described in previous studies (Boldurian and McKeel 2011; Cambron and Hulse 1961; Jolly 1972).

While patterns in the nature and frequency of fracture types potentially reflect functional behaviors, patterns of reworking and repair also reflect provisioning strategies; thus, I documented type and frequency of reworking. I calculated technological ratios such as average grinding length-to-maximum length and average flute length-to-maximum length for complete bifaces. I documented the apparent reason for abandonment to understand why and when Cumberland bifaces were deemed no longer useful.

Methods for Interpreting Settlement Strategies

While the interpretation of Cumberland settlement strategies presented here is framed in terms of provisioning strategies – *provisioning places* versus *provisioning individuals* – it is important to acknowledge that this is not a binary dichotomy, but rather represents a continual range of variation (Kuhn 1990). Furthermore, it should be noted that provisioning strategies are not static, but are flexible enough to be altered to meet seasonal or fluctuating demographic needs (Binford 1980). This is particularly relevant when one considers the evidence that late Pleistocene populations in the Southeast were regularly aggregating in macroband-level groups (Smallwood 2012).

Residentially organized strategies are marked by frequent moves between short-term residential camps with continual transport of tools in environments where resource distribution is unknown or unpredictable (Kuhn 1992). To ensure tools are available when they are needed, technology is structured around the concept of provisioning individuals with “personal gear” (Binford 1979). As such, bifaces are expected to be used to the point of exhaustion and exhibit extensive rejuvenation when they are discarded (Table 9). In addition to a high ratio of complete to broken bifaces, Pitblado (2003) suggests informal (less standardized) hafting elements and a low incidence of basal grinding reflects residential organization. Conversely, a logistically organized strategy is structured around the provisioning of specific places on the landscape. Environments where resource distribution is known or predictable and future needs can be expected favors a logistical organization strategy (Kuhn 1992). As bifacial tools

become dull or break, they are replaced rather than reworked resulting in a relatively low complete to broken biface ratio (Pitblado 2003). Additionally, bifaces are expected to have highly standardized hafting elements.

Table 9. Expected characteristics of provisioning strategies.

	Provisioning Individuals	Provisioning Place
Mobility	Residentially	Logistically
Hafting	Variable	Standardized
Intensity of use	Intensive	Non-intensive
Rejuvenation	High	Low
Reason for discard	Exhausted	Broken
Complete:Broken	High	Low

Characterizing Cumberland

Cumberland Biface Morphology

The least variable attributes of Cumberland biface morphology are maximum width (23.83 mm), basal width (20.95 mm), and inter flute thickness (5.43 mm) with CVs less than 20 percent (%) (Table 10). Maximum thickness (7.58 mm), and waist width (19.85 mm) are the next most standardized attributes, with CVs less than 25%. The average maximum length is 75.07 mm, with a CV of 33%. The average basal concavity depth is 3.17 mm with a CV of 51%, while the ratio of basal concavity depth-

to-basal width has a CV of 67%. Cumberland bifaces exhibit standardized basal elements and greater variation in length.

Table 10. Morphological characteristics of Cumberland bifaces.

	Average	Maximum	Minimum	CV
Maximum Width	23.83	52.17	10.00	0.17
Basal Width	20.95	35.61	10.00	0.18
Maximum Length	75.07	167.88	24.91	0.33
Waist Width	20.78	40.50	13.97	0.22
Waist Width:Basal Width	0.85	1.23	0.00	0.24
Waist Width:Maximum Width	0.74	1.14	0.00	0.31
Length:Width	3.14	6.02	1.12	0.26
Depth of Basal Concavity	3.17	11.02	0.00	0.51
Depth of Basal Concavity:Basal Width	0.15	1.33	0.00	0.67
Maximum Thickness	7.58	19.00	2.82	0.21
Width:Thickness	3.23	7.40	1.16	0.22
Lateral Indentation Index	0.07	0.10	0.02	0.26
Inter Flute Thickness	5.43	8.16	3.45	0.18
Face-angle	92.60	101.35	82.05	0.04

Based on morphological ratios, Cumberland bifaces are over three times longer than it is wide; likewise, width-to-thickness is approximately 3.25:1. Waist width-to-basal width and the lateral indentation index (LII) both have a CV less than 30%. Waist width-to-maximum width has a CV of 31%. These morphological ratios reflect the characteristically “waisted” shape of Cumberland bifaces, and reflect standardization in hafting methods.

Face-angle was recorded for 80 complete and finished specimens. Face-angle quantifies the expansion of the lateral edges of bifaces by measuring the angle of the lateral edges to the base (Roosa and Ellis 2000). Essentially this measurement quantifies

the relationship between basal and maximum width. Therefore, laterally reworked bifaces should be more variable, while distally reworked bifaces should be more standardized. The average face-angle of Cumberland bifaces is 92.60 degree, and is the least variable attribute with a CV of only four percent. As such, Cumberland appears to be primarily reworked from the distal tip.

Cumberland Biface Technology

Technological-related attributes in the study are focused on basal treatment and flaking techniques. Cumberland bifaces, on average, are ground to 25.47 mm from the base, or 35% of the total length (Table 11). The average flute length is 46.32 mm, or 60% of the total length. The average flute width is 11.49 mm. Average flute length, however, is considerably variable (CV = 45%), while flute widths are more standardized (CV = 29%). The variation documented in flute dimensions further suggests that Cumberland bifaces were distally reworked, with only minor modification to the lateral edges after completion. Basal beveling does not appear to be a significant attribute of Cumberland bifaces – 49% exhibit basal beveling, while 51% are not beveled.

Collateral flaking is the dominant flaking pattern (81%) documented on complete, finished specimens. This is an important aspect of Cumberland technology due to the creation of a midline ridge typically running the length of the biface. Interestingly, five percent of Cumberlands studied exhibit occasionally overface flaking similar to Clovis bifaces. These overface flake scars are likely remnants of random

Table 11. Technological characteristics of Cumberland bifaces.

	Average	Maximum	Minimum	CV
Average Grind Length	25.47	69.85	0.00	0.44
Average Grind Length: Maximum Length	0.35	0.80	0.00	0.39
Average Flute Length	46.32	118.61	7.00	0.45
Average Flute Length: Maximum Length	0.60	1.00	0.00	0.41
Average Flute Width	11.49	27.58	4.00	0.29

percussion flaking during initial bifacial reduction. Overface flaking does not appear to be an intentional reduction method for the production of Cumberland bifaces.

Thermal alteration, identified by the presence of potlid fractures, occurs in low frequency (11%) and was likely not related to the production process. Only 22 specimens exhibited signs of thermal alteration, including two preforms. Only broken fragments exhibit any evidence of being thermally altered. This suggests that heating occurred after they were discarded. Furthermore, many of the pot lid fractures are located along the margins of transverse breaks. Other specimens, such as one of the bifaces from the Phil Stratton site, explosively fractured into multiple fragments that have been refitted. Such fracture patterns further indicate the biface was exposed to high temperatures after discard.

Cumberland Biface Reduction Sequence

Of the complete Cumberland bifaces available for analysis, 93% (n = 79) exhibited a biconvex transverse cross section. The remaining seven percent (n = 6) were plano-convex in cross section. This pattern appears to be related to initial blank form used for the production of bifaces. The overwhelming majority (89%; n = 76) of complete bifaces were made from bifacial blanks. Just 11% (n = 9) of the complete bifaces, including all plano-convex specimens, were made on flakes. Bifaces made on flake blanks were identified based on the remnants of the original ventral face of the flake or pronounced longitudinal curvature. Ninety-eight percent of Cumberland bifaces were made on either Fort Payne or St. Louis cherts. Cumberland preforms were identified by the presence of fully-fluted basal fragments, and differentiated from Clovis based on the presence of collateral flaking and a midline ridge (Cambron and Hulse 1961; Jolly 1972).

Preforms were initially shaped into a rowboat form with convex lateral edges and a straight to convex base. Initial reduction and shaping was completed with large, random percussion flake removals (Figure 17a, b). The convex lateral edges typically exhibit little or no waisting. Early in the reduction sequence flaking may extend across the midline, similar to Clovis overface flaking (Figure 17b); however, this is rarely present on finished Cumberland bifaces. Once the general shape is obtained, one face is selected for fluting. Typically, each face was individually prepared for fluting (Jolly 1972). This likely represents a risk management strategy to minimize time and energy in

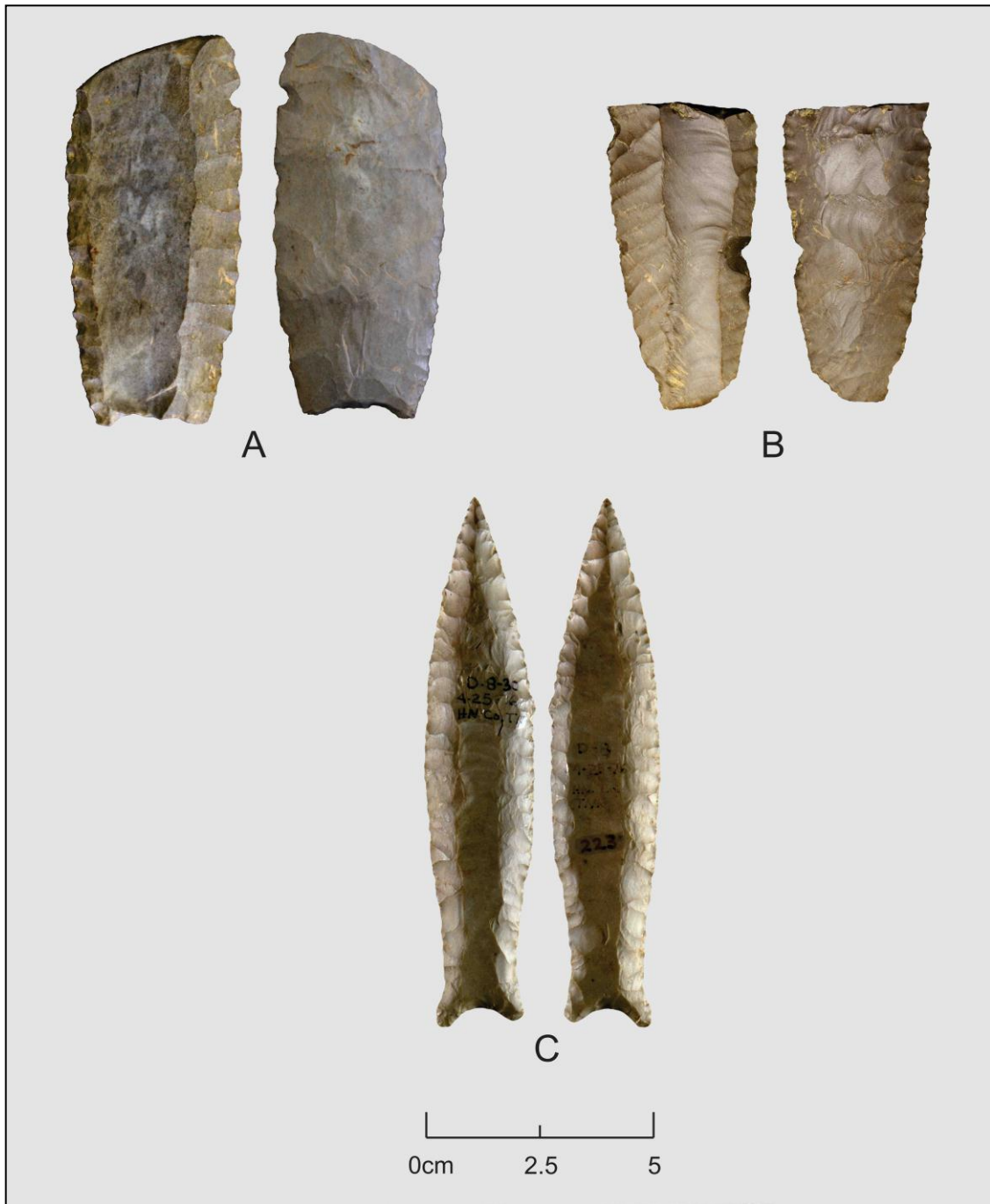


Figure 17. Examples of Cumberland preforms and a finished biface. A, Smithsonian National Museum of Natural History, Tennessee; B, Pinson State Archaeological Park (TDOA), Tennessee; and C, Parris Collection, Hardin County, Tennessee.

case the first fluting attempt catastrophically broke the preform. This was also recognized by Jolly (1972), and is exemplified in the example illustrated by Boldurian and McKeel (2011:110, Figure 4). Systematic collateral pressure flakes were removed to create a distinct midline ridge. The ridge serves to guide the removal of the channel flake and ensure that it travels the desired distance. Other researchers have noted the importance of the midline ridge and suggest that it is the most distinguishing feature of Cumberland preforms (Cambon and Hulse 1961; Jolly 1972). Immediately prior to fluting, the base is beveled and a prominent striking platform is created. Similar to Folsom (Sellet 2004), the distal ends of some Cumberland preforms are blunted suggesting the use of an anvil or brace during fluting. If the removal of the first flute is successful, then the second face is prepared for fluting following the same process. It should be noted that on roughly 20% of bifaces examined only one face is fluted. Once the channel flakes have been successfully removed, another episode of lateral pressure flaking is done to shape the final form (Figure 17c). During this final step the distinctive waisted shape is created through intensive lateral pressure flaking.

The sample of preforms available for study is inherently fragmented because only broken preforms would have typically been discarded prior to completion. The sample of 52 preforms analyzed consists of 41 basal fragments, 9 nearly complete specimens, 1 midsection, and 1 distal tip fragment. The most common reason for abandonment was catastrophic breaks caused by plunging channel flakes. Because the preforms were discarded at various points in the reduction sequence, most measurements exhibit a high rate of variation. However, certain morphological characteristics may be distinguishing

features of Cumberland preforms (Table 12). The ratio of basal width-to-maximum width is 3:4 with a relatively low CV of 19%.

Table 12. Morphological characteristics of Cumberland preforms.

	Average	Maximum	Minimum	CV
Maximum Width	35.15	57.29	26.29	0.21
Basal Width	25.85	35.61	17.59	0.18
Waist Width	28.10	37.60	20.28	0.22
Maximum Thickness	8.14	11.14	4.89	0.18
Waist Width:Basal Width	0.83	0.99	0.64	0.13
Depth of Basal Concavity	2.71	6.47	0.60	0.73
Depth of Basal Concavity:Basal Width	0.09	0.18	0.03	0.61
Inter Flute Thickness	5.09	6.91	3.79	0.21
Average Flute Width	17.92	28.82	11.97	0.26

Patterns in Cumberland Breakage and Rejuvenation

Just over half (54%) of all finished Cumberland bifaces analyzed are fractured in some way. The majority of these (n = 290, 61%) are basal fragments, while distal tips, midsections, and miscellaneous fragments account for the remaining 39%. On specimens where data were available, 25% of bifaces were missing at least one ear – excluding specimens with recent damage. Thirteen percent exhibit impact damage to the tip based on the presence of “reverse flute scars,” burination to the distal lateral edge, or crushing. The majority (70%) of Cumberland basal fragments were transversely broken. Heating accounts for almost 10% of the fractures.

Of the complete, finished Cumberland bifaces analyzed, 28% exhibited some type of rejuvenation (Figure 18). This does not include bifaces reworked into other tool types or temporally later biface types. Of reworked specimens, 18% retained evidence of impact damage near the distal tip, suggesting that Cumberland bifaces were frequently rejuvenated back into piercing tools (Figure 18a). Rejuvenation is not just restricted to the tip and lateral margins, but occasionally occurs through rebasing broken bifaces. Rebased specimens lack the characteristic waisting and flaring ears, and have a 7% thicker inter flute thickness at the base than non-rebased specimens (Figure 18c).

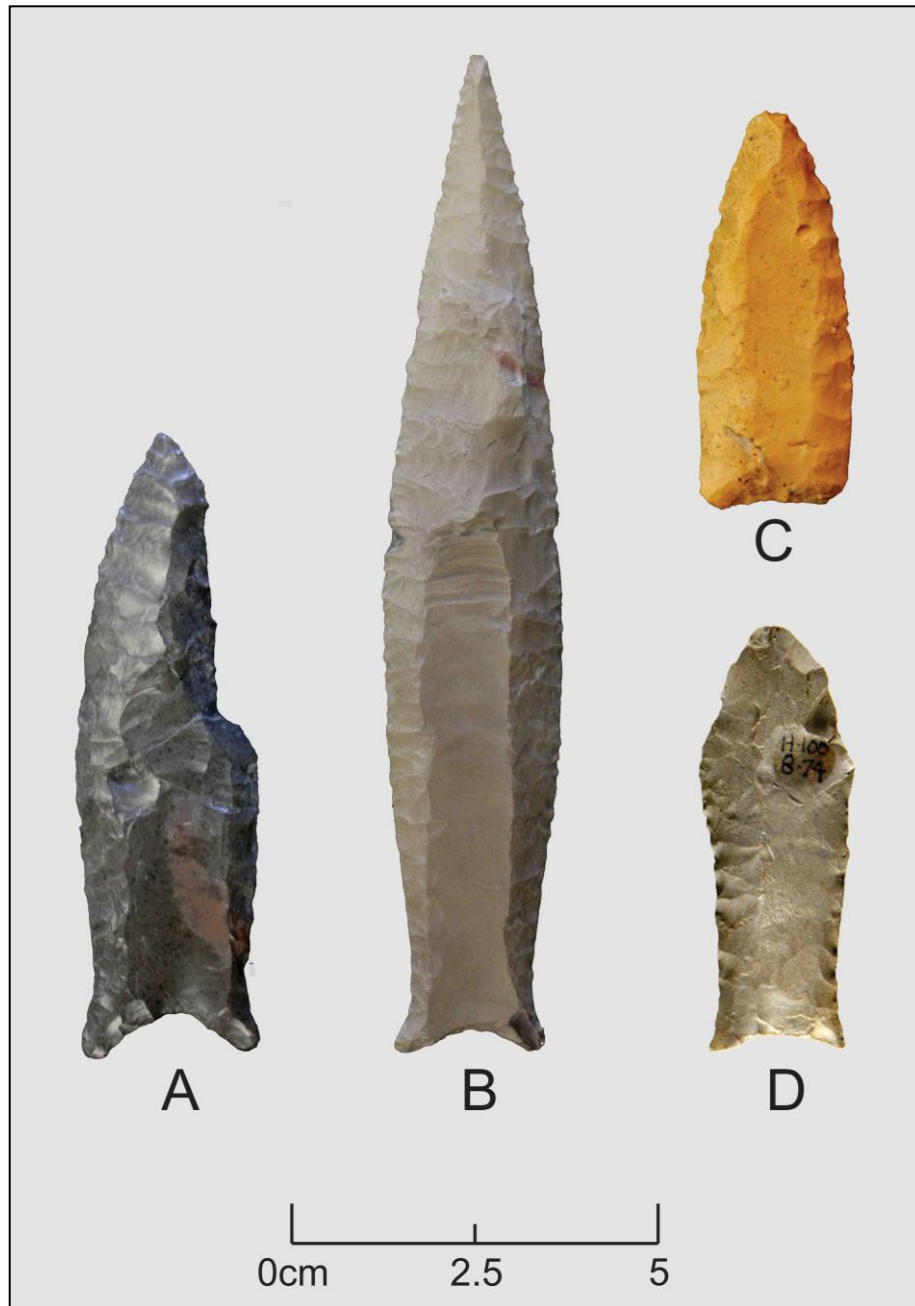


Figure 18. Cumberland bifaces in various stages of rejuvenation. A, Trinity site, Lewis County, Kentucky; B, Smithsonian National Museum of Natural History, Alabama; C, King Collection, Colbert County, Alabama; D, Parris Collection, Hardin County, Tennessee.

Cumberland Technological Organization and Behavioral Inferences

The Cumberland Technological System

The two attributes most directly related to hafting are fluting and lateral grinding. Surprisingly, flute length (CV = 45%) and the lateral grinding length (CV = 45%) are two of the most variable attributes of Cumberland bifaces. Thus, the length of flutes and grinding initially do not appear to be significant. However, if the technological ratios of flute length-to-maximum length and length of grinding-to-maximum length are considered, then these two attributes become more informative. The proportions of these measures are more standardized than the specific lengths of individual attributes. Furthermore, the technological ratios of flute length-to-maximum length and lateral grinding length-to-maximum length remain constant even after rejuvenation. Morphological ratios such as maximum length-to-width change significantly after bifaces are refurbished. Thus, it appears that technological ratios are informative and may reflect aspects of hafting and artifact use-lives. Cumberland bifaces have a relatively small width-to-thickness ratio compared to other late Pleistocene fluted bifaces (Bever and Meltzer 2007; Smallwood 2012), resulting in a more robust morphology. The majority of complete Cumberland bifaces (80%) are over 55 mm long, while the majority of Cumberland basal fragments (82%) are less than 60 mm long. As such, it appears that the minimum threshold related to discard is 55-60 mm. Bifaces above that

range are expected to be resharpened if possible, while below that length they are expected to be discarded (Figure 19). Catastrophic transverse fractures typically occur

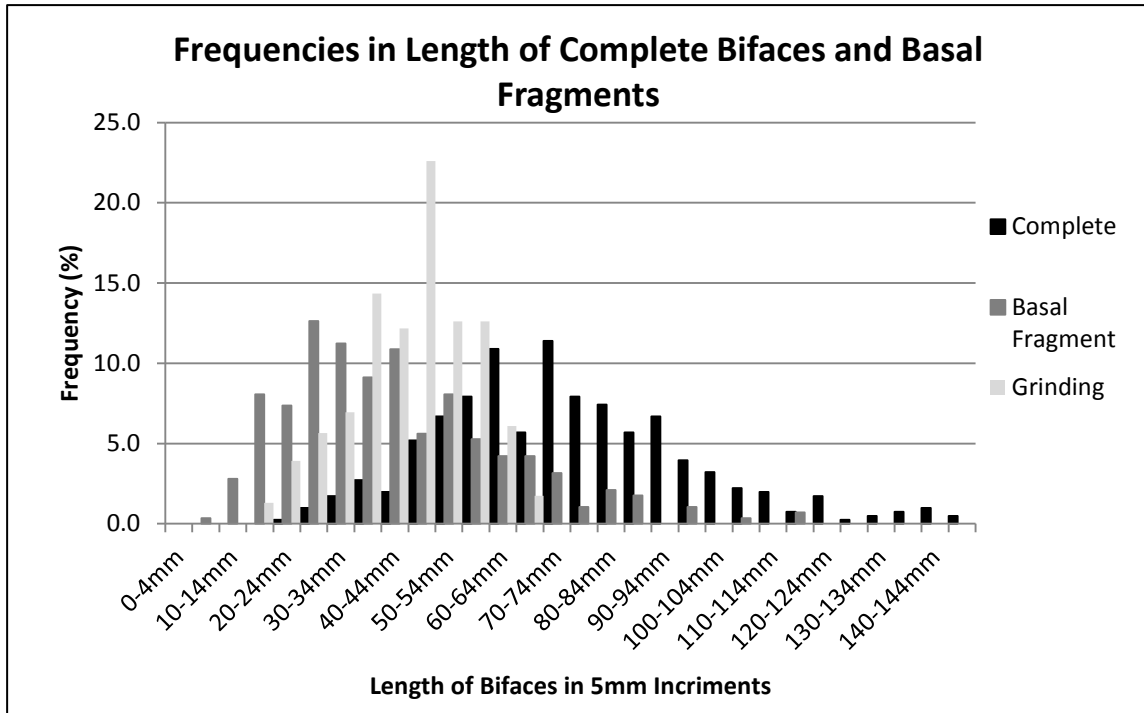


Figure 19. Frequencies in the lengths of complete Cumberland bifaces and basal fragments.

below 55 mm (80%). Based on technological ratios and assuming that lateral grinding reflects hafting, there is only a slight correlation between hafting and maximum length ($r = 0.54$, $r^2 = 0.30$), suggesting that longer bifaces did not necessarily have longer hafts.

Using the ratio of grinding length-to-maximum length is one way to infer the functional blade length. The typical Cumberland biface was hafted 35% of its total length, with the remaining 65% serving as the functional blade. If the threshold for complete

Cumberland biface length is 55-60 mm, then the minimum functional blade length was

37.75-39.00 mm. Once this threshold was reached either because of breakage or exhaustion, the biface was likely replaced.

Biface Morphology

Based on CVs for maximum measurements and morphological ratios, the most standardized attributes of Cumberland bifaces are related to the basal element. This is not unexpected given that the haft element is subject to morphological constraints imposed by specific hafting techniques (Keeley 1982; White 2013). While lateral and distal resharpening of the blade element changes the overall morphology, the hafted basal element is less frequently modified (Bever and Meltzer 2007; Meltzer and Bever 1995).

In spite of overall basal morphology being generally standardized, basal concavity is highly variable. This pattern of variability in basal concavity may be related to several factors including being tailored to individual foreshafts, stylistic elements of haft construction, and rebasing of broken bifaces (Ellis 2004; Smallwood 2012; Taylor-Montoya 2007; White 2013). Daniel and Goodyear (2006; Goodyear 2006) suggest that increased basal concavity is related to a technological shift marking the cultural transition from the early to middle Paleoindian periods. While this pattern may hold true in the Clovis-to-Redstone transition in the Coastal Plain, it does not appear to be the case with Clovis-to-Cumberland in the Midsouth. Based on Smallwood's (2012)

comprehensive study of regional Clovis morphology, Cumberland bifaces have slightly less basal concavity than Clovis bifaces.

Breakage Patterns and Rejuvenation

Whereas other fluted biface types were resharpened along the lateral margins resulting in variation in width measurements (Shott and Ballenger 2007), Cumberland bifaces appear to have been primarily resharpened from the distal tip. Distal resharpening is reflected in the standardization of face-angle and width dimensions, and the variability in length dimensions. While biface morphology may be influenced by factors related to raw material, this does not appear to be the case in the Midsouth. The ubiquity of toolstone throughout much of the Midsouth (Amick 1987; Parish 2011, 2013), nullifies potentially limiting factors caused by availability, quality, or general package size of local toolstone (Kuhn 1995).

Patterns of rejuvenation documented in Cumberland bifaces indicate that they were designed to be maintainable tools. The relatively constant widths of the bifaces, as well as the flutes, indicate that minimal resharpening occurred along the lateral margins after the biface was completed. The standardization of basal elements suggests that rejuvenating broken or dulled bifaces typically occurred with the biface in the haft. This suggests that, unlike other Paleoindian biface types (Andrefsky 2006; Collins 1993; Shott and Ballenger 2007; Yerkes and Gaertner 1997; see also Kelly 1988), Cumberland

bifaces were not multifunctional tools used for piercing and cutting, but rather were designed almost exclusively for piercing.

The Organization of Technology and Settlement Organization

The ubiquity of toolstone in the Midsouth neutralizes potential effects of resource availability, so that patterns in biface technologies reflect organization strategies rather than differential access to raw materials (Kuhn 1995). The patterns evident in overall biface morphology, hafting, breakage, rejuvenation, and discard, reflect a logistically mobile settlement strategy based around the provisioning of places. As such, Cumberland bifaces were likely specialized piercing tools used by task groups on hunting forays. Similar to Folsom, Cumberland groups likely made and maintained bifaces as part of a gearing-up strategy during periods of downtime (Sellet 2004, 2013). The low ratio of complete to broken Cumberland bifaces indicates that transverse breaks were catastrophic. However, making minor repairs to impact damaged bifaces could extend use-life. It is likely, however, that this is only part of a larger, more complex, landuse strategy that incorporated flexible provisioning strategies related to seasonal resource structure and demographic fluctuations associated with aggregation events.

Conclusion

Cumberland biface technology is prevalent throughout the Midsouth, specifically the Highland Rim of northern Alabama, central Tennessee, and southern Kentucky. Unlike other late Pleistocene technologies, Cumberland bifaces have never been recovered from intact, single component contexts with datable materials. The co-occurrence of Cumberland and other Paleoindian biface types in the same layer at sites such as Dust Cave is enigmatic. Additional sites with intact stratigraphy must be excavated to understand the intricacies of Paleoindian chronology in the Midsouth United States. Currently, there is a lack of tools and debitage, subsistence data, and radiometrically supported chronologies associated with Cumberland technology.

While Cumberland data is primarily limited to bifaces lacking context, analyses of over 900 bifaces indicate that Cumberland technology was designed to be a maintainable technological system used by people provisioning specific places on the landscape. The ubiquity of lithic raw materials and largely predictable distributions of resources allowed people using Cumberland technology to logistically map onto the woodland landscape of the Midsouth. Based on bracketing radiocarbon ages and technological similarities to other, well-dated biface technologies, Cumberland appears to be a Middle Paleoindian manifestation contemporary to the beginning of the YD (ca. 12,800-12,100 cal yr BP). However, more research is needed to definitively prove this assertion. The hypotheses presented here should be further tested with additional

technological studies of Cumberland sites with preservation of more complete toolkits and debitage.

CHAPTER IV

THE CLOVIS-CUMBERLAND-DALTON SUCCESSION: EVOLUTION OF TECHNOLOGICAL ORGANIZATION, LANDSCAPE USE, AND TOOLSTONE SELECTION DURING THE PLEISTOCENE TO HOLOCENE TRANSITION

Introduction

The relationships between YD-driven paleoecological changes and changes in human adaptations during the Pleistocene to Holocene transition have recently received much debate (Anderson et al. 2011; Ellis et al. 2011; Eren 2012; Holliday and Meltzer 2010; Meeks and Anderson 2011; Meltzer and Holliday 2010; Smallwood et al. 2015; Straus and Goebel 2011). While much of North America experienced the reversal of a general warming trend and return to tundra-like conditions, regional paleoenvironmental data show substantial variation in local conditions (Ellis et al. 1998; Eren 2012; Goebel et al. 2011; Meltzer and Holliday 2010). Anderson and colleagues (2011; Meeks and Anderson) suggest that the onset of the YD caused a significant decline or reorganization to population structure throughout the Southeast. Their hypothesis is based on a reduction in the frequency of hafted bifaces, modifications to lithic procurement strategies, and analysis of radiocarbon-dated archaeological sites.

Other researchers, however, contend that the YD may have gone unnoticed by human populations in the region (Eren 2012; Holliday and Meltzer 2010; Meltzer and Holliday 2010; Straus and Goebel 2011). Rather, factors such as sampling biases,

typological errors, and a radiocarbon plateau at the onset of the YD may influence interpretations of perceived human responses (Eren 2012; Holliday and Meltzer 2010; Meltzer and Holliday 2010; Straus and Goebel 2011). Holliday and Meltzer (2010) question the interpretation that transitions in fluted biface forms were triggered by major environmental changes. If significant modifications were made to late Pleistocene population structures, then changes should also be reflected in the organization of technologies (Bird and O'Connell 2006) and landuse strategies (e.g., Ellis 2004, 2011).

This study investigates the evolution of technological organization, landscape use, and toolstone selection to assess the potential effects of the YD on human behavioral adaptations in the Midsouth during the Pleistocene to Holocene transition. Midsouth is used here in reference to the interior Southeast and generally corresponds to the Tennessee River Watershed. I use Tennessee Paleoindian biface data compiled in the PIDBA to test for changes in behavioral adaptations and consider these changes in relation to the regional paleoecological record.

Younger Dryas and Demographic Reorganization in the Midsouth

Regardless of the cause, the YD is widely accepted to have taken place from approximately 12,900 to 11,600 cal BP (Broecker et al. 2010; Eren 2012; Fiedel 2011; Straus and Goebel 2011). The onset of the YD stands as one of the most dramatic climatic events experienced by modern humans (Meeks and Anderson 2012; Lothrop et al. 2011). However, the extent to which the YD affected human behavior is unclear.

Undoubtedly, modifications to behavioral strategies were directly related to the local severity of the YD, with some areas actually becoming more conducive to human habitation (Holliday and Meltzer 2010; Meeks and Anderson 2012; Meltzer and Holliday 2010; Shuman et al. 2002).

Anderson and colleagues (2011) have proposed a model of ecologically-driven demographic response to the YD in the Midsouth. Citing a correlation between a reduction in the frequency of bifaces, changes in lithic procurement strategies, a reduction in the number of radiocarbon ages, and the onset of the YD, they contend that ecological changes negatively affected late Pleistocene foragers. However, it is unclear if ecological changes related to the YD would have been noticed by terminal Pleistocene foragers living in the Midsouth (Eren 2012; Holliday and Meltzer 2010; Meltzer and Holliday 2010; Straus and Goebel 2011).

Alternatively, the Clovis-Cumberland-Dalton succession may represent the settling-in of local populations as they became increasingly familiar with resource distributions. Curran (1999) describes initial human migrations and occupations as a continuum with phases of exploration, colonization, and settling-in. These phases correlate well with the premise of the staging-area model – “mobility patterns were shifting rapidly from exploring... to more or less predictable patterns of movement or range mobility with specific habitual-use areas” (Anderson 1995:5). Early populations were relatively low, thus population pressures were likely not causal factors of early settlement strategies. Rather, managing resource returns, culturally defined group sizes, intergroup contacts (for the exchange of information and maintenance of mating

networks), and mobility patterns would have motivated decisions related to settlement strategies (Anderson 1995; Meltzer 2004). By using a settlement strategy focused on provisioning themselves around locally available toolstone sources, foragers are able to balance “*moving* to learn and explore and *staying* to observe” (Meltzer 2004:129; emphasis in original).

Archaeological data, at least in the Southeast, supports the hypothesis that colonization occurred through a slower “place-oriented” settlement strategy with intensive exploitation of local resources (Miller 2011; Smallwood 2012; Thulman 2006). Smallwood (2012) identified morphological variation in Clovis biface technology that likely represents isolation and divergence of regionally distinct populations from within a larger Clovis tradition. Anderson and Sassaman (2012) suggest that such interregional variation may represent antecedent populations for later lithic technologies such as Cumberland. Mobility generally becomes more logistically oriented as foragers continued to settle-in. Therefore, the portability of toolkits became less important (Shott 1986), and more robust tool forms (e.g., wood-working tools) began to emerge (Ellis et al. 1998).

Paleoecology of the Midsouth

The fossil pollen record from the Midsouth and surrounding regions, while limited, provides some indication of paleoecological conditions at the onset of the Pleistocene to Holocene transition. Prior to the YD, a northern expansion of deciduous

forests began to replace existing boreal species (Delcourt 1979; Delcourt and Delcourt 1985; Liu et al. 2013; Watts 1970). Two of the most well-studied pollen cores from the Midsouth come from Anderson Pond in Tennessee and Jackson Pond in Kentucky (Delcourt 1979; Delcourt and Delcourt 1980; Liu et al. 2013; Wilkins et al. 1991). Liu and colleagues' (2013:196) detailed analyses of those cores reveals that by 15,900-15,400 cal yr BP the Midsouth had shifted from conifer to *Quercus*-dominated no-analog deciduous pollen assemblage. That transition reflects the onset of increasing regional temperatures and precipitation, and possibly the local extinction of megafaunal populations. Overall, the climate throughout the Midsouth was marked by warmer and moister conditions, and an expansion of mixed deciduous hardwood communities (Delcourt et al. 1983; Delcourt and Delcourt 1985; Hollenbach and Walker 2010; LaMoreaux et al. 2009). Furthermore, a positive correlation between the influx of oak, hickory, and 25 other species, indicates an increasingly diverse forest community as the Holocene developed (Delcourt 1979).

Using Information from PIDBA

Stratified, radiocarbon-datable sites are notoriously rare in the Southeast, and completely absent in the case of Cumberland (Anderson 2005; Anderson et al. 2015; Dunnell 1990; Goodyear 1999; Miller and Gingerich 2013). Regional surficial geology is primarily composed of residuum with limited, if any, sediment accumulation since initial human migration into the region (Dunnell 1990; Goodyear 1999). The warm,

humid climate and acidic soils further limit preservation of datable materials (Dunnell 1990). The few radiocarbon dates that do exist typically come from cave and rockshelter sites (e.g., Dust Cave and Stanfield-Worley).

While the precise dating and cultural associations of Paleoindian biface types are incomplete, the general chronological sequence encompassing Clovis, post-Clovis fluted, and unfluted lanceolate forms is generally accepted in eastern North America (Anderson and Sassaman 1996; Anderson et al. 2010, 2015; Bradley et al. 2008; Ellis and Deller 1997; Fiedel 1999; Goodyear 1999; Meltzer 2009; Tankersley 1990, 1996; see Gramly 2013 for alternative).

However, exceptional fluted point survey data has been collected by statewide surveys and compiled in PIDBA (Anderson 2004; Anderson et al. 2010; Goodyear 1999; Miller and Gingerich 2013). Potential biases and limitations are well known for PIDBA datasets and include incomplete data, sample inconsistency, site formation processes, ground cover (Anderson et al. 2010; Ballenger et al. 2011; Prasciunas 2011). However, such data are commonly accepted for modeling human behaviors (Anderson and Gillam 2000; Meeks and Anderson 2012; Anderson et al. 2011; Lanata et al. 2008; Miller 2011; Shott 2013; Smallwood 2012; Smallwood et al. 2015). As such, analyzing biface data, and assessing patterns in the selection and movement of lithic materials throughout the Midsouth, facilitates the comparison technological organization, landscape use, and toolstone selection throughout the Clovis-Cumberland-Dalton succession.

Methods

This study analyzes Clovis, Cumberland, and Dalton hafted bifaces documented in PIDBA (Anderson et al. 2010) from Tennessee based on the 2013 statewide update. The Tennessee state Paleoindian survey was restarted and maintained by John B. Broster and Mark Norton, of the Tennessee Division of Archaeology in the late 1980s (Broster 1989). All biface identifications in the database were made by them; thus, limiting inter-observer errors in typological identifications. Only data from complete bifaces and basal fragments are used to minimize typological errors caused by more fragmentary specimens. Only fluted Clovis and Cumberland bifaces are included in this study. While exceptional variation in the Dalton type has been documented and expressed as numerous sub-types (Cambron and Hulse 1964; Justice 1987), bifaces identified only as “Dalton” are included here to further eliminate additional typological errors.

To assess changes in the relative intensity of biface use during the Pleistocene to Holocene transition, I compared length to body width ratios as a relative measure of reduction. Binford (1973, 1979) first recognized the significance of assessing tools in terms of how they change over time as a way to study the organization of technology. This is most apparent on the portion of the biface outside of the haft. While Clovis and Dalton were used as multifunctional tools (Ahler 1971; Ballenger 2001; Galm and Hofman 1984; Morse 1971; Smallwood 2015), Cumberland appears to be specialized tools designed for piercing. Though each technology was used and rejuvenated in slightly different ways, the end result is always a reduction in mass from the overall

form. Numerous methods have been developed to assess use and rework of bifaces (e.g., Andrefsky 2006; Buchanan 2006); however, many are specific to certain types of bifaces (e.g., Shott and Ballenger 2007). The simple, but effective, use of length-to-width correlation (Kuhn and Miller 2015) overcomes typologically-specific technological elements (e.g., fluting) that prevent the application of certain reduction measures. Assuming that hafted bifaces of individual types originate as fairly standardized shapes, “there should be a high correlation between lengths and widths of new points” (Kuhn and Miller 2015:186). Throughout the life history of each biface the ratio of length to width will change as mass is reduced, regardless if the biface is reduced distally or laterally. Therefore, there should be a lower correlation between length and width of bifaces that have been more intensively reduced (Kuhn and Miller 2015). Only bifaces classified as complete were used for technological analyses.

The evolution of land-use strategies during the Pleistocene to Holocene transition was assessed based on county-level biface density data. County densities were analyzed based on all complete bifaces and basal fragments documented in PIDBA. Physiographic comparisons were made by grouping counties into eight physiographic regions: the Alluvial Plain, Coastal Plain, Highland Rim, Central Basin, Cumberland Plateau, Cumberland Mountains, Ridge and Valley, and Blue Ridge Mountains (Fenneman 1917).

I compared relative frequencies of lithic material types used to make bifaces to document changes in toolstone selection over time. The regional lithic landscape was determined from surficial geologic formations that contain toolstone-quality

cryptocrystalline silicates. While numerous region-specific chert subtypes have frequently been used in previous studies (e.g., Dover, Waverly, and Buffalo River), recent material source studies have shown that macroscopic typological identifications frequently produce inaccurate results due to extreme variability within individual geologic formations (Parish 2011, 2013; Parish and Durham 2015). As such, all chert subtypes that occur within the Fort Payne formation are treated as a single type, and classified here as *Fort Payne*. Likewise, all subtypes within the St. Louis formation are classified as *St. Louis*. All other materials (including Camden and Burlington cherts, agate, and quartzite) are classified as *other*. Material type densities and distributions were analyzed from complete bifaces and basal fragments with unequivocal material identifications.

Results

A total of 2,634 Clovis, Cumberland, and Dalton bifaces are reported from Tennessee, including unspecified fragments and preforms. However, only finished complete bifaces and basal fragments unequivocally identified to a single type are used in this study, which leaves 1,307 bifaces in the revised dataset. This includes 670 Clovis, 384 Cumberland, and 255 Dalton bifaces (Table 13).

Table 13. Frequencies of bifaces used in this study by type and condition.

	Basal		Total	Ratio
	Complete	Fragment		
Clovis	347	323	670	1.07
Cumberland	204	180	384	1.13
Dalton	226	29	255	7.79

Technological Organization

Table 14 shows the results of Pearson's correlations between length and width for complete specimens of all three biface types, and Figures 20-22 present the corresponding scatter plots. Clovis ($r = 0.609$ $p = <0.001$) and Cumberland ($r = 0.570$ $p = <0.001$) have similar positive correlations between length and width. This pattern suggests that Clovis and Cumberland had similar life histories and may have been discarded near the same point in their reduction trajectories. The length and width of Dalton, however, has no correlation ($r = -0.089$, $p = 0.185$). This lack of correlation suggests that Dalton bifaces were heavily reworked and discarded at, or near, the point of exhaustion.

Table 14. Results of Pearson's correlations between length and body width.

	N	r	r^2	p
Clovis	347	0.609	0.371	<0.001
Cumberland	204	0.570	0.325	<0.001
Dalton	226	-0.089	0.008	0.185

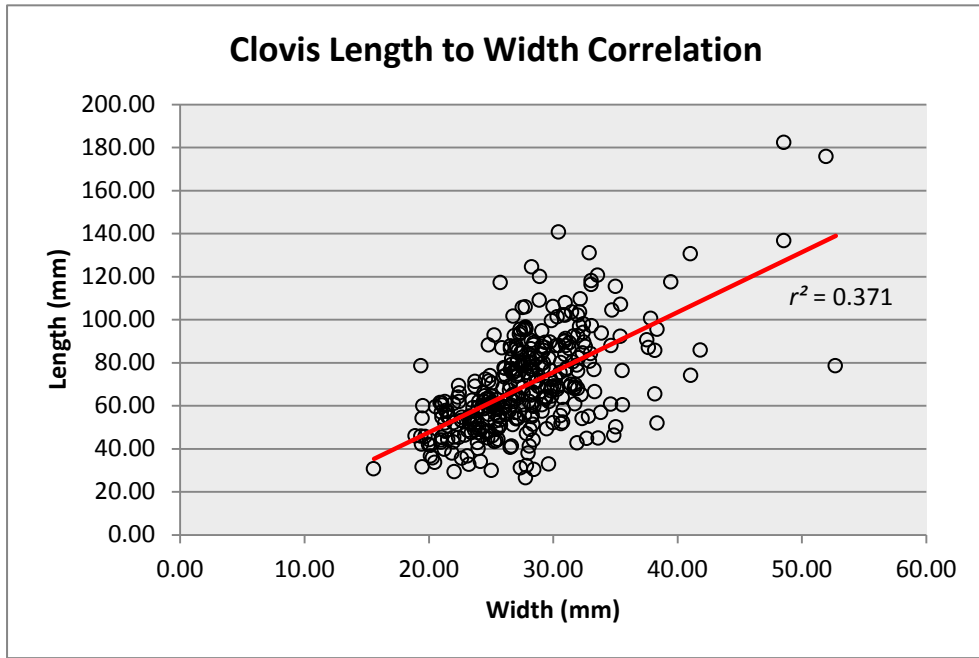


Figure 20. Plot of Clovis length versus body width for complete bifaces from Tennessee (n = 347).

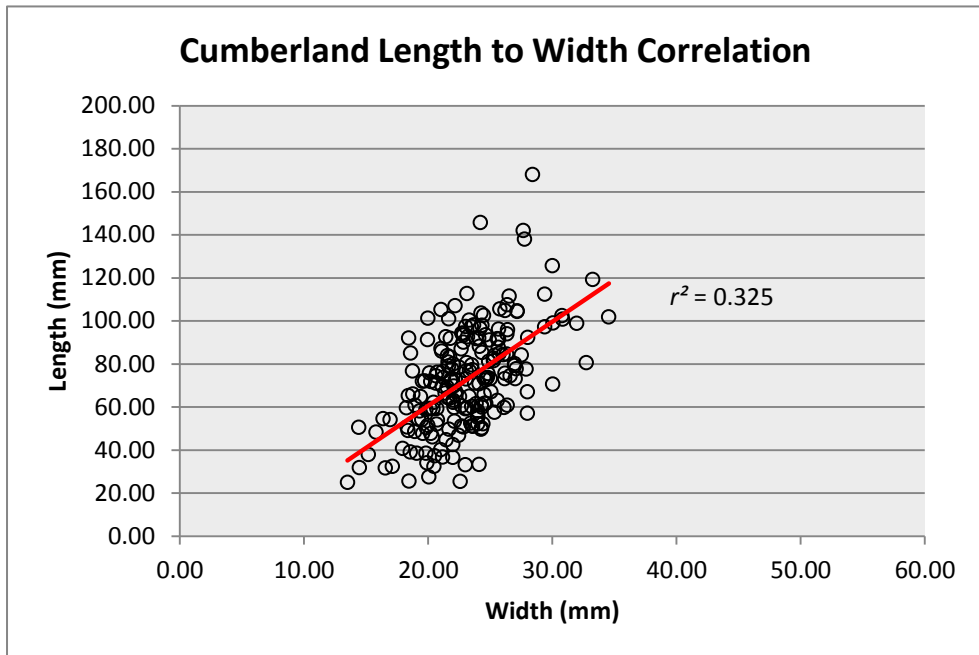


Figure 21. Plot of Cumberland length versus body width for complete bifaces from Tennessee (n = 204).

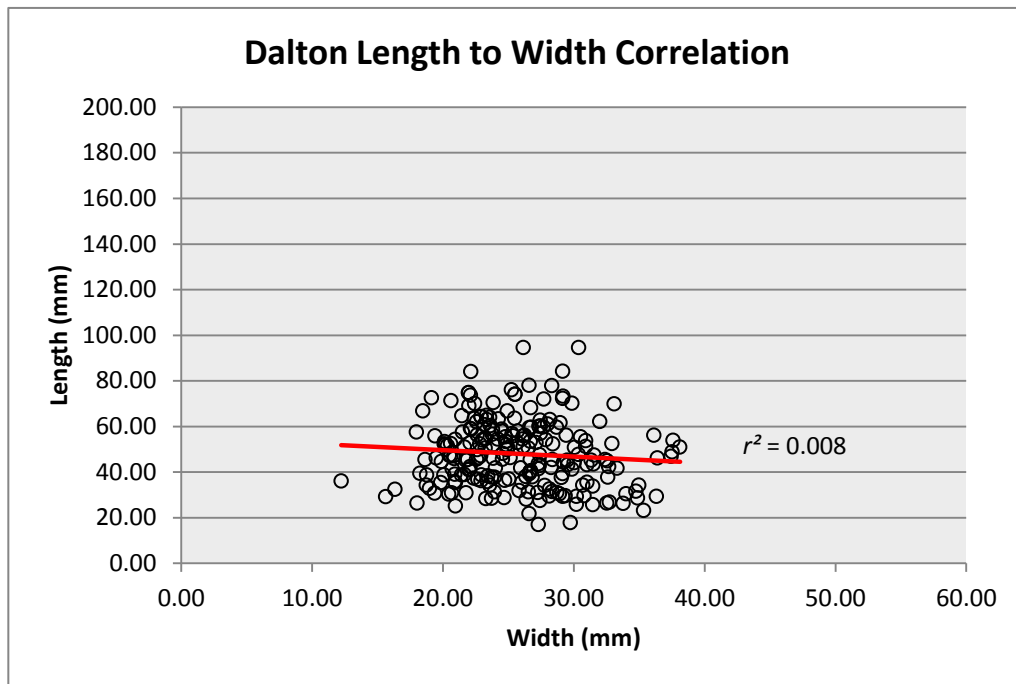


Figure 22. Plot of Dalton length versus body width for complete bifaces from Tennessee (n = 226).

Summary statistics for morphological attributes are presented in Table 15.

Whether hafted bifaces are used strictly for piercing, cutting, or are multifunctional, hafted basal elements should remain more constant (Shott 1997; Shott and Ballenger 2007). While thickness varies between biface types, CVs are similar, and may also reflect basic hafting requirements of all lanceolate hafted bifaces. As expected, the most standardized attributes are associated with the basal element, and presumably relate to hafting requirements.

Table 15. Descriptive statistics for morphological measurements of Paleoindian bifaces.

		Max. Length	Basal Width	Body Width	Basal Concavity:Basal Width	Max. Thickness
Clovis	Mean	69.50	24.76	27.79	0.15	6.63
	Std. dev.	22.62	3.77	4.96	0.07	1.42
	CV	0.33	0.15	0.18	0.46	0.21
Cumberland	Mean	72.29	20.41	23.03	0.16	7.06
	Std. dev.	23.85	3.25	3.47	0.06	1.35
	CV	0.33	0.16	0.15	0.39	0.19
Dalton	Mean	49.93	26.66	25.31	0.14	6.93
	Std. dev.	13.55	4.05	4.30	0.06	1.04
	CV	0.27	0.15	0.17	0.42	0.15

Comparing the overall structures of Clovis, Cumberland, and Dalton biface assemblages reveals significant differences. The ratios of complete-to-broken Clovis and Cumberland bifaces are just over one-to-one, indicating that almost equal numbers of exhausted and broken bifaces were discarded. Complete Dalton bifaces, however, were discarded nearly eight times more frequently than broken bifaces. This pattern suggests that either Dalton bifaces broke at a much lower frequency, or that broken bifaces were typically refurbished back into functional tools.

Landuse

Plotting the distribution of biface frequencies by county reveals clear patterns in statewide densities (Figure 23). All three biface types are recorded throughout the state.

Higher densities of bifaces of all types are generally located towards the center of the state, with two counties exhibiting markedly denser concentrations than the rest of the state, with two counties exhibiting markedly denser concentrations than the rest of the state,

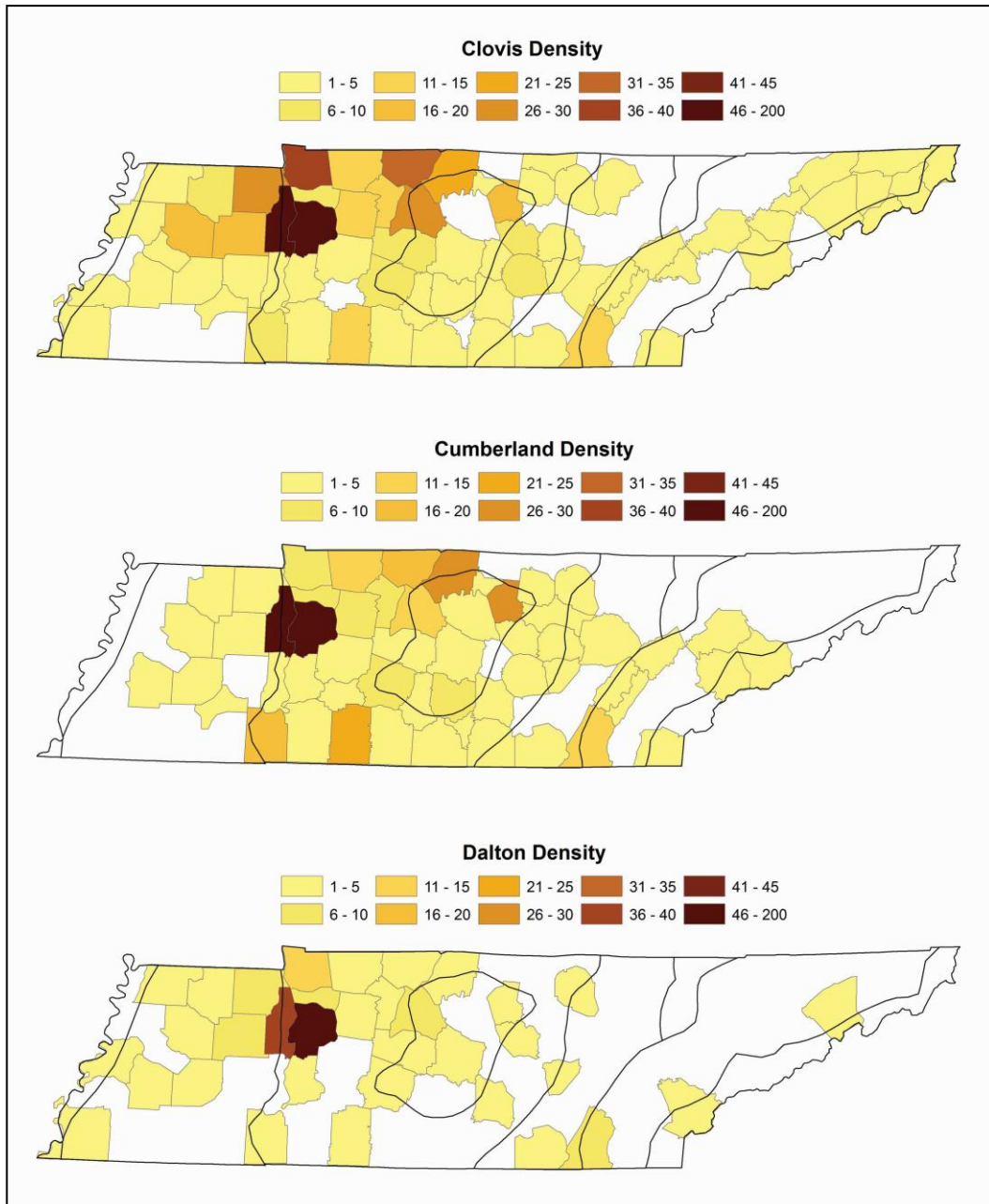


Figure 23. Density maps for each biface type showing frequencies by county and physiographic region.

state. Benton and Humphreys counties border the confluence of the Lower Tennessee and Duck Rivers. Notably, this portion of the Tennessee River Valley has been significantly impacted by the impoundment of Kentucky Lake. As a result, the majority of bifaces recovered from this area are from deflated shorelines. The exceptionally high biface densities warrant consideration of potential sampling biases (see Anderson et al. 2010; Lepper 1983, 1985; Prasciunas 2011; Seeman and Prufer 1982; Shott 2002). However, Miller (2011) has demonstrated that selective recovery biases are likely not a significant factor in county-level data in the Midsouth. Rather, higher concentrations of Paleoindian bifaces are documented at the intersections of rivers, ecotones, and lithic sources, and may reflect land-use strategies (Miller 2011).

Assessing biface distribution by physiographic region provides additional explanation. The Cumberland Mountains are the only physiographic region where Paleoindian bifaces have not been documented. As such, this region is omitted in additional analyses. The distributions of Clovis, Cumberland, and Dalton differ significantly by physiographic region (Table 16) ($\chi^2 = 34.87$, $df = 14$, $p = <0.01$). While all biface types occur at expected frequencies in the Alluvial Plain, Ridge and Valley, and Blue Ridge Mountains, these regions have extremely small sample sizes. Clovis occurs at an expected frequency in the Cumberland Plateau, but at lower than expected frequencies in the Highland Rim and Central Basin. The frequency of Clovis bifaces in the Coastal Plain is higher than expected. Cumberland occur at expected frequencies in the Highland Rim, but higher than expected in the Central Basin and Cumberland

Table 16. Counts and percentages of bifaces found in each physiographic region.

		Alluvial Plain	Coastal Plain	Highland Rim	Central Basin	Cumberland Plateau	Cumberland Mountains	Ridge and Valley	Blue Ridge Mountains	Total
Clovis	Count	1	153	394	73	15	0	28	6	670
	Expected	1.2	120.4	421.1	79.0	18.3	0.0	26.0	4.2	670
	% of biface type	0.15	22.84	58.81	10.90	2.24	0.00	4.18	0.90	100
Cumberland	Count	0	42	239	69	16	0	16	2	384
	Expected	0.7	69.0	241.2	42.3	10.5	0.0	14.9	2.4	381
	% of biface type	0.0	10.9	62.2	18.0	4.2	0.0	4.2	0.5	100
Dalton	Count	1	40	190	12	5	0	6	1	255
	Expected	0.4	46.0	160.8	30.2	7.0	0.0	9.9	1.6	256
	% of biface type	0.4	15.7	74.5	4.7	2.0	0.0	2.4	0.4	100
Total	Count	2	235	823	154	36	0	50	9	1309
	Expected	2.3	235.4	823.1	151.4	35.7	0.1	50.8	8.3	1307
	% of all bifaces	0.2	18.0	62.9	11.8	2.8	0.0	3.8	0.7	100

Plateau. The Coastal Plain, however, has lower than expected frequencies for Cumberland. The frequency of Dalton is as expected in the Cumberland Plateau, but lower than expected in the Coastal Plain and Central Basin. The Highland Rim has a higher than expected frequency for Dalton.

The frequencies of bifaces by physiographic region further illustrate distribution patterns (Figure 24). The vast majority of bifaces across all types occur in the Highland Rim (62.9%). The Coastal Plain (18%) has the next highest frequency, closely followed by the Central Basin (11.8%). The Ridge and Valley, Cumberland Plateau, Blue Ridge Mountains, and Alluvial Plain have much smaller frequencies, cumulatively totaling 7.5 percent of all bifaces.

To further interpret Paleoindian landscape use, the densities of bifaces were scaled to account for differing sizes of physiographic regions (Figure 17). The overall pattern corresponds well to the gross regional densities, although the relative biface densities are slightly different. The highest density of bifaces occurs with Clovis in the Highland Rim at 11.92 bifaces per 1,000 km², followed by the Central Basin (7.49 per 1,000 km²), and Coastal Plain (6.62 per 1,000 km²) (Table 5). A similar pattern is evident in Cumberland and Dalton. Cumberland bifaces occur essentially in equal densities in the Highland Rim (7.23 per 1,000 km²) and Central Basin (7.08 per 1,000 km²), followed by the Coastal Plain (1.82 per 1,000 km²) and Cumberland Plateau (1.32 per 1,000 km²). Dalton occurs in the highest density in the Highland Rim (5.75 per 1,000 km²), followed by the Coastal Plain (1.73 per 1,000 km²) and the Central Basin (1.23 per

Table 17. Biface densities per 1,000 km² for each physiographic region of Tennessee.

	Area (km²)	Clovis (per 1,000 km²)	Cumberland (per 1,000 km²)	Dalton (per 1,000 km²)	Total (per 1,000 km²)
Alluvial Plain	2,787	0.36	0.00	0.36	0.72
Coastal Plain	23,102	6.62	1.82	1.73	10.17
Highland Rim	33,040	11.92	7.23	5.75	24.91
Central Basin	9,740	7.49	7.08	1.23	15.81
Cumberland Plateau	12,120	1.24	1.32	0.41	2.97
Cumberland Mountains	1,920	0.00	0.00	0.00	0.00
Ridge and Valley Blue Ridge Mountains	20,066	1.40	0.80	0.30	2.49
	6,372	0.94	0.16	0.16	1.26
Total	109,147	29.98	18.41	9.94	58.33

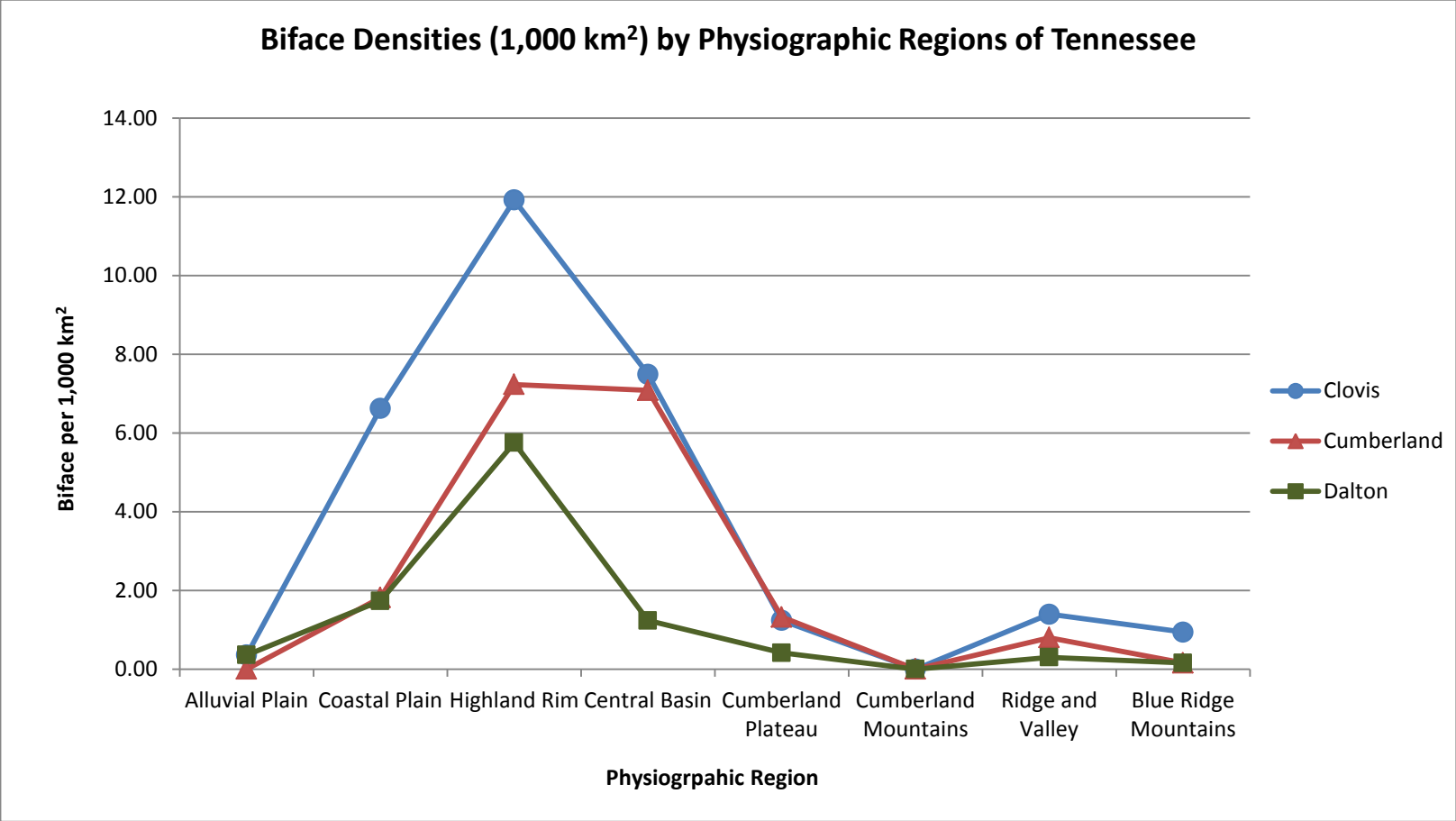


Figure 24. Line graph of biface densities in each physiographic region by biface type, per 1,000 km².

1,000 km²). All biface types occur in very low densities (less than 1.00 per 1,000 km²) in the Alluvial Plain and Blue Ridge Mountains.

Toolstone Selection

The lithic landscape of the Midsouth is characterized by an abundance of high-quality cherts that are readily available in tabular and cobble forms (Amick 1987; Parish 2011, 2013). The underlying bedrock is comprised of the chert-bearing Fort Payne and St. Louis limestone formations. Cherts from these two formations frequently occur in primary contexts in cliffline outcroppings and secondary contexts in alluvial deposits (Amick 1987). The distribution of these formations directly correlates to the Highland Rim, essentially creating a chert-rich ring encircling the Central Basin (Figure 25). Cherts from both formations occur throughout the Highland Rim. However, Fort Payne is dominant to the southwest between the Duck and Elk Rivers, while St. Louis is dominant in the northwest.

Fort Payne (45%) and St. Louis (50%) cherts are by far the dominant materials throughout all three biface types (Figure 26). Clovis bifaces made from both chert types occur at expected frequencies, as Clovis knappers used both materials evenly (Figure 27, Table 18). The Cumberland and Dalton assemblages, however, demonstrate significantly different patterns ($\chi^2 = 81.65$, $df = 1$, $p = <0.001$). Cumberland knappers preferentially

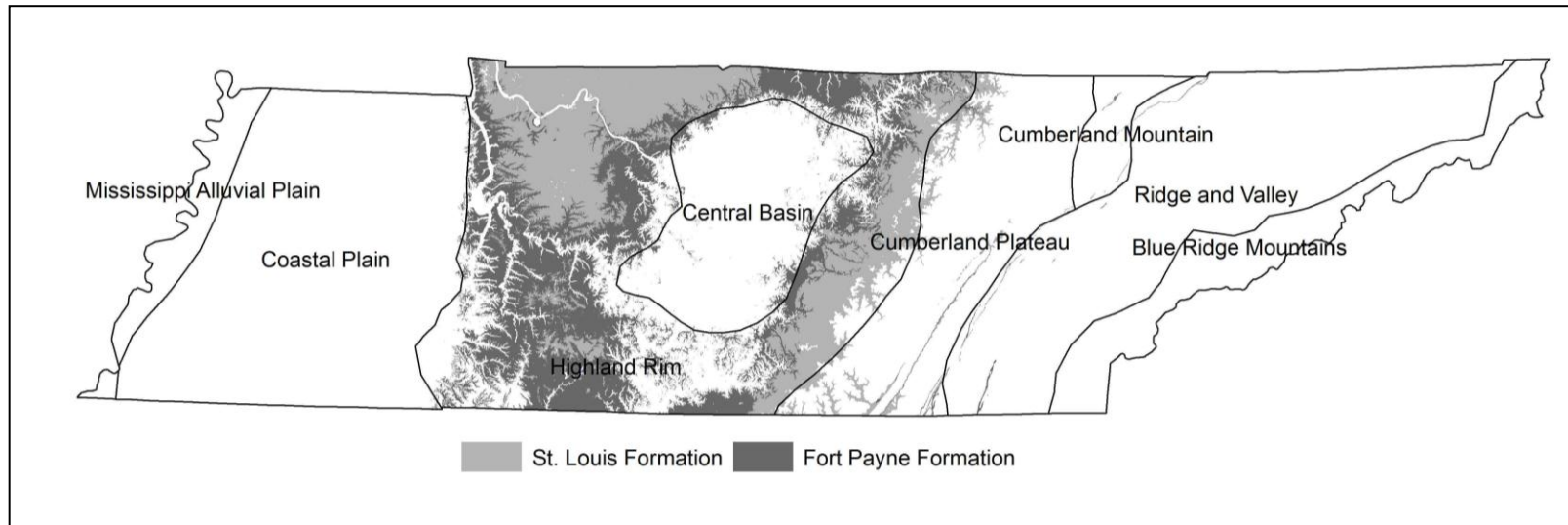


Figure 25. Physiographic regions and major chert-bearing geologic formations in Tennessee.

selected Fort Payne chert, which occurs at a higher than expected frequency, while St. Louis occurs at a lower than expected frequency (Figure 28). Dalton knappers, on the other hand, appear to have favored St. Louis chert, which occurs at a higher than expected frequency, while Fort Payne is lower than expected. Dalton knappers' apparent preference for St. Louis, however, is skewed by two sites, which account for 61% (n = 103) of the material (Figure 29). When those two sites are removed Dalton toolstone use is more evenly distributed between Fort Payne (43%) and St. Louis (50%).

While materials other than Fort Payne and St. Louis only comprise a small portion of the overall dataset (5%), a notable pattern exists. Other materials occur at, or below, expected frequencies and account for small amounts of Cumberland (2%) and Dalton (4%) materials. For the Clovis dataset, however, other materials occur at a higher than expected frequency and account for eight percent of Clovis material. This pattern may reflect larger territorial ranges, and be related to landscape learning by initial colonizers.

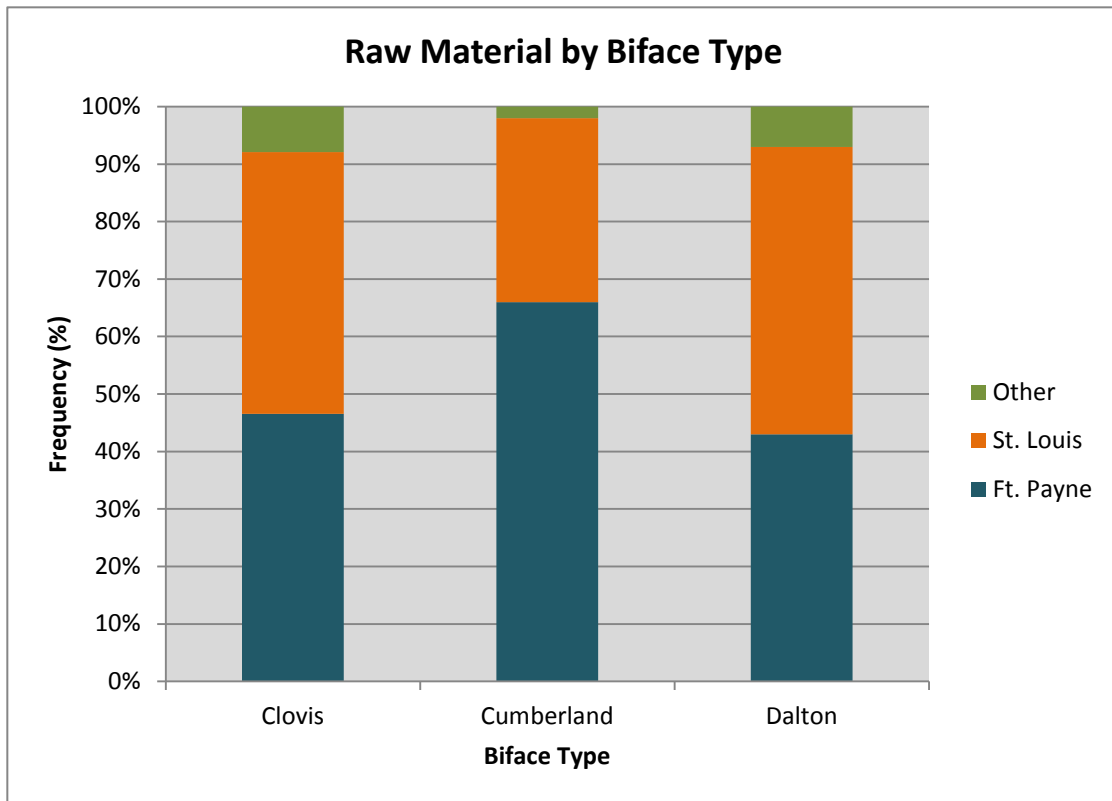


Figure 26. Relative frequencies of lithic materials by biface type.

Table 18. Counts and percentages of bifaces by type and raw material.

		Fort Payne	St. Louis	Other	Total
Clovis	Count	137	133	22	292
	Expected	131.4	146.8	13.8	292
	% of biface type	0.47	0.46	0.08	1.00
Cumberland	Count	143	70	4	217
	Expected	97.7	109.1	10.2	217
	% of biface type	0.66	0.32	0.02	1.00
Dalton	Count	54	170	9	233
	Expected	104.9	117.1	11	233
	% of biface type	0.23	0.73	0.04	1.00
Total	Count	334	373	35	742
	Expected	334	373	35	742
	% of all bifaces	0.45	0.50	0.05	1.00

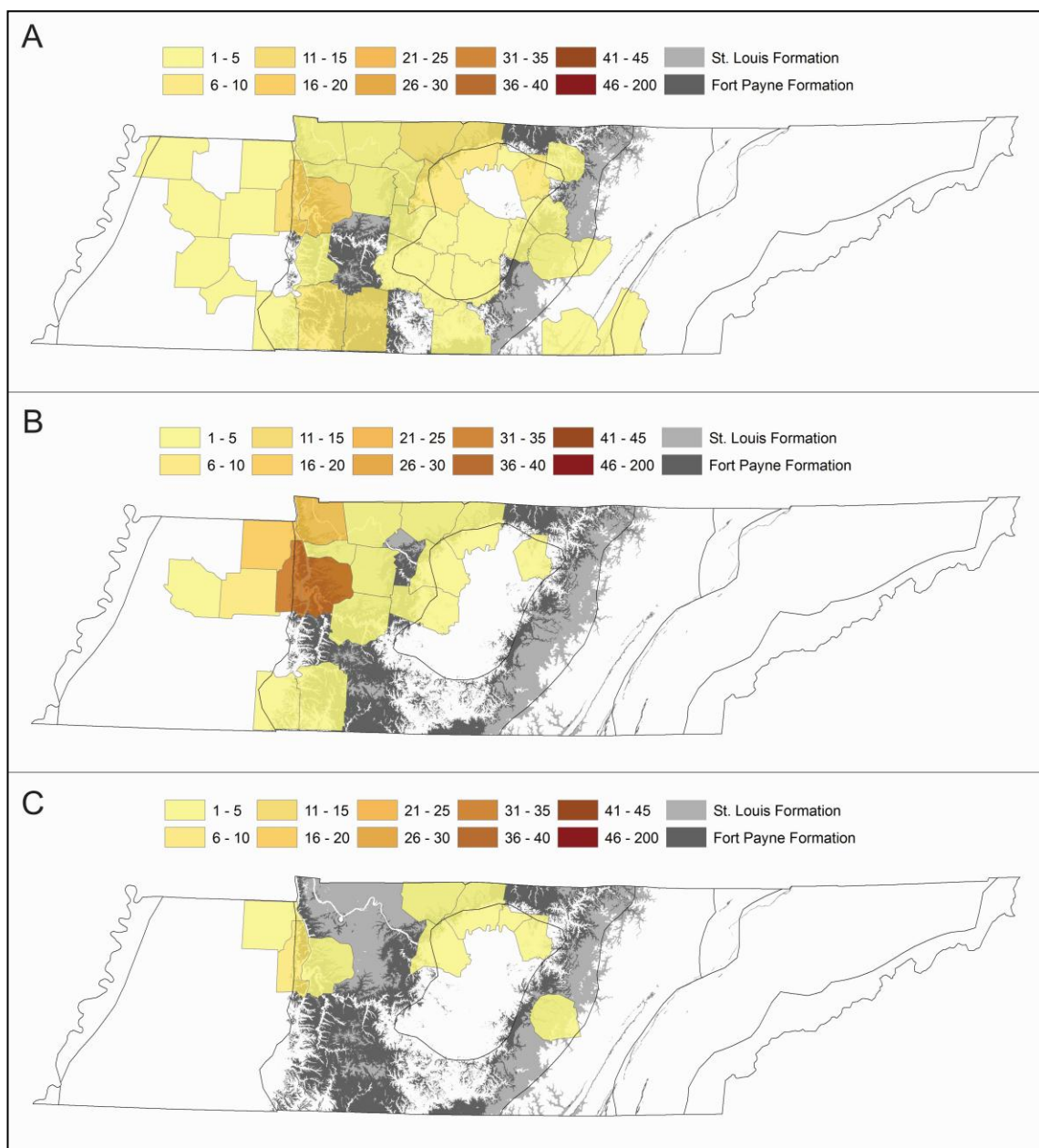


Figure 27. Distribution of Clovis bifaces by raw material type. A, Fort Payne; B, St. Louis; C, Other.

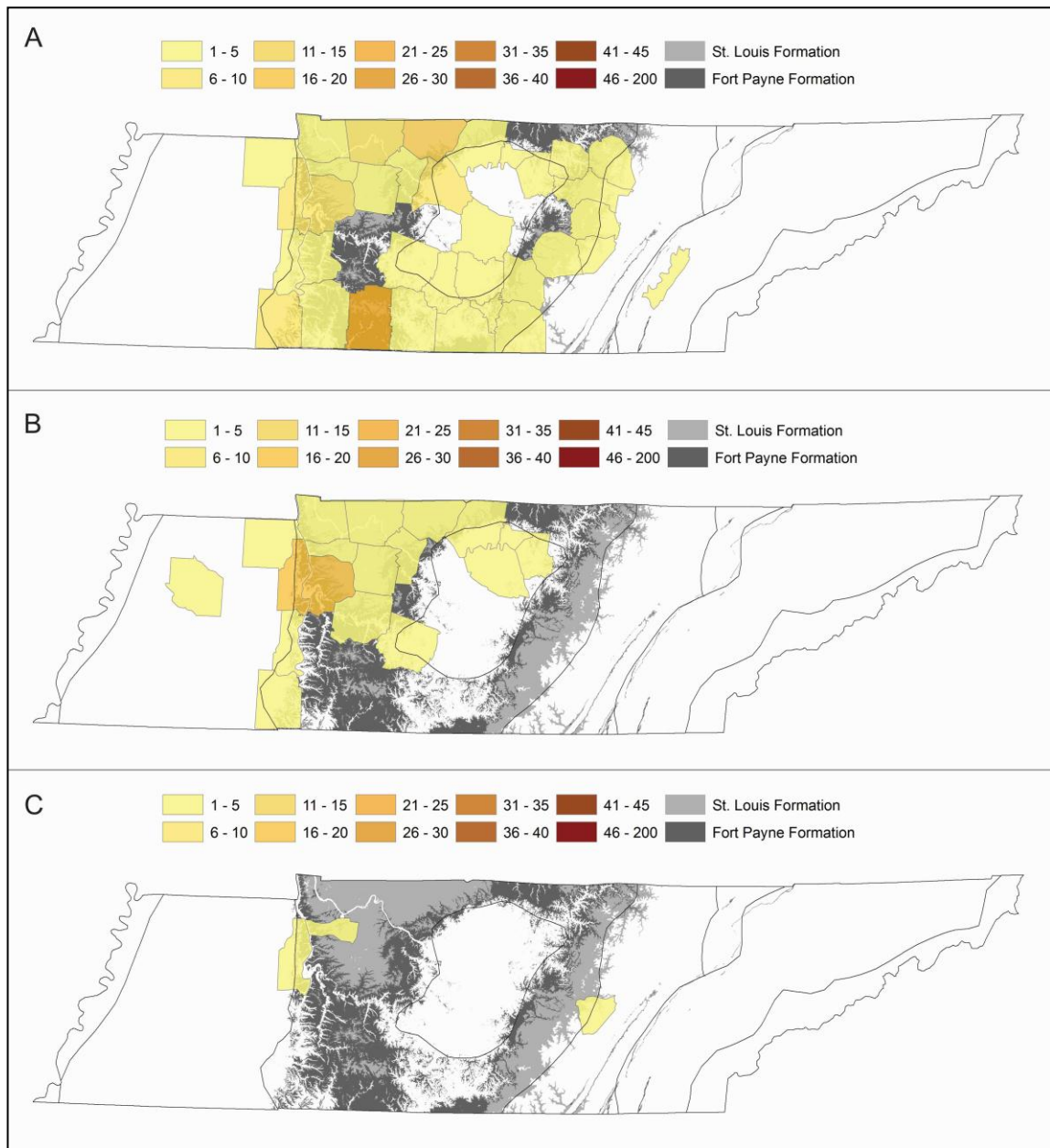


Figure 28. Distribution of Cumberland bifaces by raw material type. A, Fort Payne; B, St. Louis; C, Other.

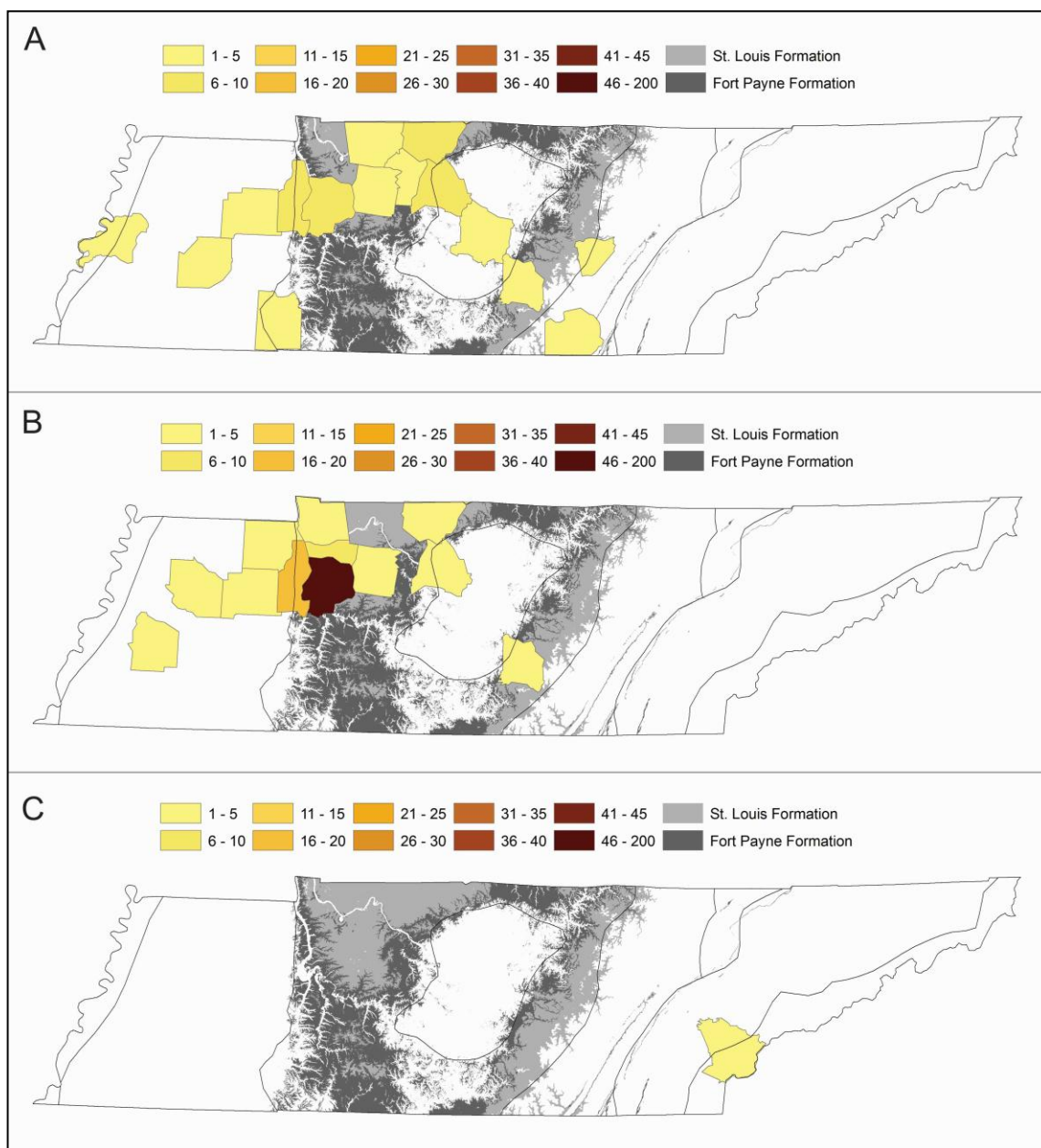


Figure 29. Distribution of Dalton bifaces by raw material type. A, Fort Payne; B, St. Louis; C, Other.

Discussion

The onset of the YD has been suggested as causing a significant decline or substantial reorganization of population structure throughout the Southeast (Anderson et al 2011; Meeks and Anderson 2012). However, other researchers contend that the YD may have gone unnoticed by human populations in the region (Eren 2012; Holliday and Meltzer 2010; Meltzer and Holliday 2010; Straus and Goebel 2011). Recent research has demonstrated relationships exist between changes in landscape use and environmental changes associated with the YD in some areas of the coastal Southeast due to fluctuations in sea level (Smallwood et al. 2015). Datasets related to technological organization, landscape use, and toolstone selection in Tennessee provide insights into the possible effects of the YD on populations living in the Midsouth, and suggest an alternative scenario occurred in the interior Southeast.

Anderson and colleagues (2011; Meeks and Anderson 2012) contend that a reduction in the frequency of post-Clovis fluted bifaces reflects adverse ecological conditions at the beginning of the YD; whereas, an increase in later bifaces, especially Dalton, corresponds to improved ecological conditions. Essentially this corresponds to a Clovis-to-Cumberland collapse followed by a Cumberland-to-Dalton rebound. While data from the coastal Southeast supports this hypothesis, such a pattern is not reflected in the data from Tennessee. Rather, there is a continual decline in relative biface frequencies throughout the Pleistocene to Holocene transition. The apparent contradiction in these two datasets reflects the complexities of regional population

models and behavioral adaptations related to changing paleoecological conditions in North America before, during, and after the YD. While people living in some areas (e.g., coastal Georgia) were adversely affected by environmental conditions during the beginning of the YD (Smallwood et al. 2015), populations in the Midsouth do not appear to have reorganized their population structure or technologies in response to YD-related conditions. Behavioral adaptations in the Midsouth are characterized by increasing regionalization and a great emphasis on local resources. Aspects of early regionalization have been previously documented in Clovis technology (Smallwood 2012). Increasingly smaller and more rigidly bounded territories continued to drive diversification of technologies resulting in greater regional complexity in biface types.

Clovis and Cumberland have strong statistical correlations between length and width, complete-to-broken discard ratios of approximately one-to-one. This pattern suggests similar life histories between Clovis and Cumberland, and indicates that when bifaces were broken, they were typically discarded. Conversely, there is no correlation between the length and width of Dalton bifaces, which have a complete-to-broken discard rate of nearly eight-to-one. The lack of correlation indicates that Dalton bifaces were heavily reworked. This is not unexpected given the results of previous studies modeling expended utility in Dalton assemblages (e.g., Goodyear 1974; Shott and Ballenger 2007). Because of intensive biface conservation in the Dalton technological system, broken bifaces would have likely been reworked back into a functional state rather than being discarded.

Morphologically, however, Dalton is slightly more standardized than Clovis and Cumberland based on the CVs for length and thickness. Kuhn and Miller (2015) identified a similar pattern from a different dataset. Their interpretation, which I support here, is that Clovis and Cumberland bifaces were made in a range of sizes and because they were less intensively used, discarded bifaces retain morphological ratios similar to their initial form. Whereas Dalton bifaces were more intensively used and discarded at a more uniform point (Kuhn and Miller 2015). The extended use lives of Dalton bifaces obscures any effect of original size.

Considering potential relationships between changes in landscape use and paleoecological changes may further explain the evolution of biface life histories during the Pleistocene to Holocene transition. Based on a modified Marginal Value Theorem, Kuhn and Miller (2015) suggest that increased population densities affecting access to raw materials, and changes in local faunal resources may lead to bifaces being more intensively used for longer periods of time. Increased populations would have led to more restricted and rigid territorial boundaries, and increased competition and demand of raw materials.

A second, and complimentary, explanation for changes in biface life histories relates to changing biological resource structures throughout the Pleistocene to Holocene transition (Kuhn and Miller 2015). Coinciding with increasingly restricted territories, paleoecological changes were rapidly occurring throughout the Midsouth. Pollen core data reflects a transition from conifer to *Quercus* had already begun by ca. 15,000 cal yr BP and possibly corresponded with the extinction of large herbivores (Liu et al. 2013).

Subsequently, pollen assemblages became increasingly diverse as the Pleistocene ended (Delcourt 1979). As people began to target smaller species, average returns of successful hunts decreased as search and handling costs rose (Kuhn and Miller 2015). While preservation issues limit faunal data from the region, sites such as Dust Cave in northern Alabama demonstrate that people were targeting a high diversity of small faunal species during the Late Paleoindian period (Walker 2007).

Based on spatiotemporal distributions of bifaces in Tennessee, increasingly smaller bounded territories developed throughout the Pleistocene to Holocene transition. While the Highland Rim and Central Basin have the highest densities, regardless of biface type, there is a generally greater geographic distribution of Clovis in comparison to Cumberland and Dalton. In all physiographic regions Clovis bifaces occur at the same or higher density per 1,000 km² than later biface types. With the exception of the Alluvial Plain, bordering the Mississippi River in west Tennessee, Cumberland bifaces occur in greater densities than Dalton.

This overall pattern suggests that landscape learning was occurring throughout the Pleistocene to Holocene transition as people were continuing to settle-in to the region. Increased familiarity with local resource distribution likely led to more localized resource acquisition. Early indications of regionalization have been identified in Clovis assemblages throughout the Southeast (Smallwood 2012; Thulman 2006). Landscape use throughout the Pleistocene to Holocene transition in the Midsouth seems to reflect a pattern of increasing regionalization as distributions of biface types become more restricted.

The temporal trend of increasingly localized technologies is also reflected in toolstone selection. As Clovis is assumed to be the first distinctly recognizable technology in the region (Anderson et al. 2015), it follows that there should be greater variety of material types in the overall Clovis dataset. That assumption is supported by data from Tennessee, where Clovis bifaces were made on materials other than Fort Payne and St. Louis cherts at twice the frequency seen in Cumberland and Dalton datasets. People using Cumberland technology were preferentially selecting Fort Payne chert over twice as frequently as St. Louis chert, in spite of both material types occurring throughout the Highland Rim. While Dalton knappers appear to have used St. Louis slightly more than Fort Payne, the distribution of Dalton bifaces closely corresponds to the distribution of the St. Louis formation (Figure 11). This pattern suggests that people using Dalton bifaces in the Midsouth may not have been necessarily preferentially selecting one material type over the others, but were simply making use of the local resources because of constrained territorial boundaries.

The relationship between mobility and curation is related to resource availability (Bamforth 1986; Shott 1986). Mobile foragers that are unfamiliar with the local lithic landscape are unable to predict the distribution of toolstone sources. Thus, those individuals are expected to transport non-local materials with them as they venture into unfamiliar territories (Kelly 1988; Kuhn 1995; Odell 1996; Parry and Kelly 1987). Less mobile foragers are typically familiar with the local lithic landscape and know where toolstone sources are located. As a result, they can strategically provision themselves around toolstone sources (Kelly 1988; Kuhn 1995; Odell 1996; Parry and Kelly 1987).

As foragers continued to settle-in throughout the Clovis-Cumberland-Dalton succession, they increasingly relied on local lithic materials over time.

Conclusion

To assess the effects YD-related paleoecological conditions had on human behavioral adaptations in the Midsouth, I investigated the evolution of technological organization, landscape use, and toolstone selection throughout the Clovis-Cumberland-Dalton succession. This study takes a localized perspective to understand sub-regional relationships between behavioral strategies and paleoecological conditions in the interior Southeast. Considering the Paleoindian archaeological record in relation to regional paleoecological data provides an opportunity to evaluate relationships between potentially YD-driven ecological changes and human behavioral adaptations.

Changes in paleoecological conditions at the onset of the YD do not appear to have lead to human population decline or reorganization in the Midsouth. While the overall frequency of Cumberland bifaces dramatically declines immediately following Clovis at the beginning of the YD, there is not a corresponding rebound in Dalton bifaces at the end of the YD. Rather, there is a continual decline in relative frequencies of individual biface types going into the Holocene. Biface technologies throughout the Pleistocene to Holocene transition trend toward longer use lives with increasingly intensive reduction. Bounded territories appear to become more rigid and increasingly

restricted from Clovis to Cumberland to Dalton, while toolstone selection becomes more focused on locally available sources.

An alternative interpretation based on regionalization associated with settling in processes may explain long-term changes in human behavioral adaptations in the Midsouth. Kuhn and Miller's (2015) modified Marginal Value Theorem predicts that as regional populations increase and territories become more constricted, competition for resources increases. While the lithic landscape of the Midsouth is characterized by an abundance of high-quality toolstone, there is a visible shift to increasing local sources throughout the Clovis-Cumberland-Dalton succession. Increasingly localized dependence for lithic raw material combined with increasing populations drives competition. Additionally, as megafaunal species became extinct and people focused on a diverse suite of small faunal species, average return rates are reduced due to increasing search and handling costs. As return rates decrease, there are longer intervals between replacing tools, resulting in longer biface life histories as people extend biface utility through increased reduction (Kuhn and Miller 2015). The overall patterns in technological organization, landscape use, and toolstone selection reflect a trend of increasing regionalization that began to develop with Clovis (e.g., Smallwood 2012) and was well-established by Dalton.

CHAPTER V

CONCLUSION

While there is still some debate as to when people first arrived in North America, we know that by ca. 13,000 cal yr BP Clovis technology had been dispersed throughout most of the continent. People utilizing this technology adapted to a diversity of environments with different resource structures. Throughout the Pleistocene to Holocene transition populations presumably expanded and foraging groups began to develop more constricted territorial ranges. In turn, increased divergence and isolation of populations resulted in diversity in biface technologies by the end of the Pleistocene. This dissertation characterizes the evolution of Paleoindian adaptations in the Midsouth United States, and considers the effects of YD-driven environmental changes on those adaptations.

There is increasingly greater evidence and support for pre-Clovis occupations in North America (e.g., Jenkins et al. 2012; Johnson 2006; Joyce 2006; Overstreet 2005; Waters et al. 2011a, 2011b). One of the most compelling potentially pre-Clovis sites in the Midsouth is the Coats-Hines-Litchy site, in middle Tennessee (Haynes 2015; Grayson and Meltzer 2015). While previous research at the site indicates that humans may have butchered at least one mastodon, questions persist as to the age of the deposits, context of the artifacts and bones, and site formation processes.

I conducted a multidisciplinary investigation of new and existing data to address those questions. During a large-scale excavation of the site, I collected new material for

radiocarbon dating, and led geoarchaeological, faunal, and lithic analyses. I also re-analyzed all lithic artifacts previously recovered from the site. A suite of 14 radiocarbon ages obtained on charcoal, demonstrate that the late Pleistocene sediments containing the bone-bearing deposits are at least 22,000 ^{14}C yr BP (26,000 cal yr BP). The highly fragmentary and battered nature of the faunal assemblage, in addition to the geoarchaeological study of the sediments, indicate that the materials were redeposited in an erosional channel composed of course-grained colluvial and alluvial sediments. The high-energy geomorphic environment, in conjunction with the natural sediment matrix, further fragmented the faunal remains, while also producing linear groves on the bones reminiscent of butchering marks. Culturally-produced lithic artifacts from nearby Holocene-aged archaeological sites were redeposited in the erosional channel and where subsequently recovered in close proximity to late Pleistocene bonebed. Physical weathering of nearby bedrock outcroppings combined with high-energy colluvial and alluvial processes appear to have naturally fractured local cherts, resulting in flakes and angular shatter with artifact-like attributes.

Cumberland biface technology presumably follows Clovis in the Midsouth and is likely contemporaneous with the beginning of the YD. However, unlike other late Pleistocene technologies, Cumberland bifaces have never been recovered from intact, single component contexts with datable materials. The co-occurrence of Cumberland and other Paleoindian biface types in the same layer at sites such as Dust Cave, in northern Alabama, is enigmatic. Additional sites with intact, datable components are needed to confirm the regional Paleoindian biface sequence. The lack of unequivocal single-

component Cumberland sites has significantly limited the amount of research focused on Cumberland technology.

I studied over 900 Cumberland fluted bifaces from the Midsouth region to document quantitative and qualitative attributes. This enabled me to characterize the range of variation within the Cumberland type and to document the reduction sequence. Basal elements are the most standardized attributes of Cumberland bifaces, and likely reflect basic requirements of hafting strategies. Biface width is significantly more standardized than length. Considered with patterns of breakage and resharpening, this suggests that Cumberland bifaces were designed to be specialized weapons for piercing rather than multifunctional tools. Based on bracketing radiocarbon ages and technological similarities to other, well-dated biface technologies, Cumberland appears to be a Middle Paleoindian technology contemporary to the beginning of the YD (ca. 12,800-12,100 cal yr BP). However, more research is needed to definitively prove this assertion.

Anderson and colleagues (2011; Meeks and Anderson 2012) suggest that the onset of the YD caused a significant decline or reorganization to population structure in the Southeast. They cite a reduction in the frequency of hafted bifaces, modifications to lithic procurement strategies, and an analysis of radiocarbon-dated archaeological sites as support of their hypothesis. However, regional YD-age Paleoindian adaptations are relatively poorly understood in the region. Furthermore, other researchers contend that the YD may have gone unnoticed by people living in the region (Eren 2012; Holliday and Meltzer 2010; Meltzer and Holliday 2010; Straus and Goebel 2011).

I investigated the evolution of technological organization, landscape use, and toolstone selection to assess potential YD-related effects on human adaptations in the Midsouth. I compare Clovis, Cumberland, and Dalton bifaces in Tennessee to understand the evolution of Paleoindian adaptations during the Pleistocene to Holocene transition. Changes in paleoenvironmental conditions at the onset of the YD do not appear to have caused noticeable changes in Paleoindian adaptations in the Midsouth. Clovis and Cumberland bifaces had similar life histories, while Dalton bifaces were resharpened much more intensively resulting in extended use lives. Bounded territories appear to become increasingly constricted, and toolstone selection becomes more focused on locally available sources throughout the Pleistocene to Holocene transition. Patterns in technological organization, landscape use, and toolstone selection reflect an overall trend of increasing regionalization that began to develop with Clovis and was well-established by Dalton. I suggest that regionalization of populations associated with settling in processes may explain long-term changes in Paleoindian adaptations in the Midsouth.

How foraging groups adapted to new environments and changing ecological conditions is integral to Paleoindian archaeology. While late Pleistocene technologies are similar throughout the continent, Paleoindian foragers modified their adaptations to cope with local environmental requirements. This dissertation presents new data related to the evolution of Paleoindian adaptations throughout the Pleistocene to Holocene transition in the Midsouth United States. By recognizing temporal and spatial changes in late Pleistocene technologies, and considering those changes in relation to

paleoenvironmental records, we are better suited to understand Paleoindian adaptations. In turn, we are able to construct more robust and accurate settlement models to explain the peopling of the Americas.

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