RESEARCH REPORT

The Clovis–Cumberland–Dalton Succession: Settling into the Midsouth United States during the Pleistocene to Holocene Transition

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Considerable debate has recently focused on understanding the effects of the Younger Dryas (YD) on human behavioral adaptations throughout the Northern Hemisphere. It has been proposed that adverse paleoecological conditions in southeastern North America triggered a decline or substantial reorganization in human populations. The Tennessee Paleoindian biface data in the Paleoindian Database of the Americas is used here to assess transitions in behavioral adaptations during the Pleistocene to Holocene transition. Patterns in technological organization, land use, and toolstone selection do not support the hypothesis that paleoecological changes during the YD adversely affected human populations in the Midsouth. An alternative hypothesis is proposed and contends that changes in behavioral adaptations were a result of settling in processes associated with initial regional colonization and increased regionalization throughout the Pleistocene to Holocene transition.

Keywords Paleoindian, Younger Dryas, technological organization, landscape use, toolstone selection

1. Introduction

The relationships between Younger Dryas (YD) driven paleoecological changes and modifications of human adaptations during the Pleistocene to Holocene transition have recently received much attention (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 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 et al. (2011; Meeks and Anderson 2012) suggest that the onset of the YD caused a significant decline or reorganization of populations throughout the greater Southeast. Their hypothesis is based on an overall 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 are also expected to be reflected in the organization of technologies (Bird and O'Connell 2006) and land-use strategies (e.g., Ellis 2004, 2011).

This study investigates transitions in technological organization, land-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 compare Clovis, Cumberland, and Dalton data from Tennessee that is compiled in the Paleoindian Database of the Americas (PIDBA) to investigate potential YD related technological and behavioral changes in late Pleistocene populations.

1.1. *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

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cal BP (Broecker et al. 2010). The onset of the YD stands as one of the most dramatic climate events experienced by modern humans (Lothrop et al. 2011; Meeks and Anderson 2012). 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 et al. (2011) have proposed a model of ecologically driven demographic response to the YD in the greater Southeast. 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 impacted 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 people 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, in which "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 relying on 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, support the hypothesis that colonization occurred through a slower "place-oriented" settlement strategy with intensive exploitation of local resources (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).

1.2. *Regional radiocarbon and Paleoindian biface data*

Stratified, radiocarbon-dated 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; Tune 2015). 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 of Paleoindian biface types is incomplete, the chronological sequence of Clovis, post-Clovis fluted, and unfluted lanceolate forms is generally accepted in eastern North America (Anderson et al. 2010, 2015; Anderson and Sassaman 1996; Bradley et al. 2008; Ellis and Deller 1997; Fiedel 1999; Goodyear 1999; Meltzer 2009; Tankersley 1990, 1996; but see Gramly 2013 for alternative). In the Midsouth, Clovis, Cumberland, and Dalton are generally thought to represent biface technologies before, during, and after the onset of the YD (Anderson et al. 2015; Broster et al. 2013; Meeks and Anderson 2012). Therefore, if YD related ecological changes did impact populations in the Midsouth, then differences in technological and behavioral responses should be visible in the Clovis–Cumberland–Dalton succession.

While there are very few radiocarbon ages associated with Paleoindian components in the Southeast, exceptional fluted-biface survey data exist for much of the region (Anderson et al. 2010). Potential biases and limitations are well known for such datasets and include incomplete data, sample inconsistency, site-formation processes, and ground cover (Anderson et al. 2010; Ballenger et al. 2011; Prasciunas 2011). However, such data are commonly accepted for modeling certain human behaviors (Anderson and Gillam 2000; Anderson et al. 2011; Kuhn and Miller 2015; Lanata et al. 2008; 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 facilitate the comparison of technological organization, land use, and toolstone selection throughout the Clovis–Cumberland–Dalton succession.

Recent use-wear studies have demonstrated that while Clovis bifaces were generally used as projectiles, at times they were also used for other functions (Bradley et al. 2010; Smallwood 2015; Waters et al.

2011). Relatively little research has been devoted to the potential functions of Cumberland bifaces. Based on technological analyses, however, Cumberland bifaces were likely used primarily for piercing as projectiles (Tune 2015). There is extensive research indicating that Dalton bifaces were multifunctional tools (Ballenger 2001; Galm and Hofman 1984; Goodyear 1974; Morris 1971; Walthall and Holley 1997; Wyckoff and Bartlett 1995); however, some researchers contend that they were primarily used as projectiles (O'Brien and Wood 1998). Regardless of their primary function, what is critical to this study is how the production, use, and distribution of these three biface types changed over time.

2. Methods

This study analyzed Clovis, Cumberland, and Dalton bifaces documented in PIDBA from Tennessee based on the 2013 statewide update (Anderson et al. 2010). While all of these biface types are frequently documented in states throughout the entire southeastern region, the Paleoindian database from Tennessee is one of the only statewide surveys that includes all three biface types. All biface identifications in the dataset used here were made by John Broster and Mark Norton with the Tennessee Division of Archaeology, thus minimizing potential inter-observer errors. Only data from complete bifaces and basal fragments were used to further minimize typological errors caused by more fragmentary specimens. Unfluted forms of Clovis and Cumberland bifaces were not included in this study. While exceptional variation in the Dalton type has been documented and expressed as numerous subtypes (Cambron and Hulse 1964; Justice 1987), bifaces identified only as "Dalton" were included here to further minimize additional typological errors.

Biface morphologies were measured using standard metric values: maximum length, basal width, body width, and maximum thickness. Basal morphologies were documented using the ratio of basal concavity to basal width. A coefficient of variation (CV) was calculated for each measurement and used to evaluate relative degrees of standardization between biface types (Eerkens and Bettinger 2001). Whether hafted bifaces were used strictly for piercing, cutting, or were multifunctional, basal elements should remain relatively constant (Shott 1997; Shott and Ballenger 2007). Overall patterns in biface conditions were compared as a way to evaluate when bifaces were discarded.

Numerous methods have been developed to assess use and reworking of bifaces (e.g., Andrefsky 2006; Buchanan 2006); however, many are specific to certain types of bifaces (e.g., Shott and Ballenger 2007). Thus, to assess changes in the relative intensity of biface use, I compared length-to-body width ratios as a relative measure of reduction. Throughout the use-life of each biface, the ratio of length-to-width is expected to change as mass is reduced, regardless if the biface is reduced distally, laterally, or both. A strong, positive correlation between these two variables indicates that both dimensions were consistently reduced throughout the use-life of the biface. Assuming that hafted bifaces of individual types originate as generally standardized shapes, there should also be a relatively high correlation between the lengths and widths of bifaces that have not been extensively reworked (Kuhn and Miller 2015).

Changes in land-use strategies throughout the Pleistocene to Holocene transition were assessed based on county-level biface data. County densities were analyzed based on all complete bifaces and basal fragments documented in PIDBA. Absolute counts and relative percentages of bifaces were compared across physiographic regions to further interpret land-use patterns and assess relative territorial ranges. The proportions of each biface type were compared by physiographic region to assess potential territorial range sizes. Physiographic comparisons were made by grouping counties into eight physiographic regions previously defined for Tennessee (Fenneman 1917).

I compared relative frequencies of lithic materials by biface type to document changes in toolstone selection over time. The regional lithic landscape was assessed by identifying surficial geologic formations that contain toolstone-quality materials. The Midsouth is characterized by an abundance of toolstone-quality cherts that are readily available in tabular and cobble forms (Amick 1987; Parish 2011, 2013). The dominant chert-bearing geologic formations are the Fort Payne and St. Louis Formations. The distribution of these formations closely corresponds to the Highland Rim, essentially creating a chert-rich ring encircling the Central Basin (Figure 1). While numerous region-specific chert subtypes have frequently been used in previous studies (e.g., Dover, Waverly, and Buffalo

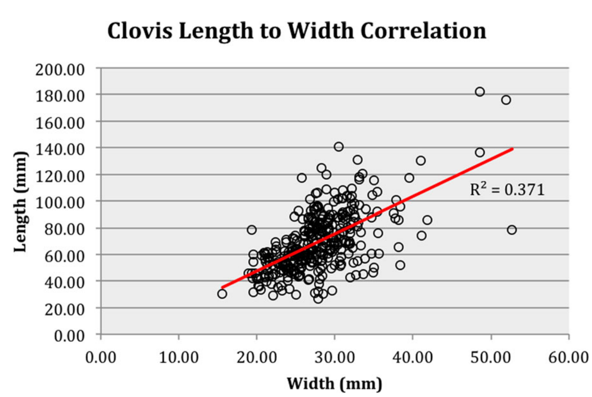

Figure 1 Plot of Clovis length versus body width for complete bifaces from Tennessee (n = 347).

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 were treated as a single type, and classified here as "Fort Payne". Likewise, all subtypes within the St. Louis Formation were classified as "St. Louis". All other materials (i.e., Burlington and Camden cherts, agate, and quartzite) were classified as "Other". Burlington and Camden cherts can be found throughout western Tennessee and Kentucky, and into central Illinois and Iowa (Marcher and Stearns 1962; Willman et al. 1975). Agate and quartzite can be found in various deposits throughout Tennessee, including Tennessee River gravels (Kaye 1974; Paris 2011).

3. Results

A total of 2634 Clovis, Cumberland, and Dalton bifaces are reported from Tennessee, including unspecified fragments and preforms. Only finished, complete bifaces and basal fragments unequivocally identified to a specific type were included in this study, which leaves 1307 bifaces in the revised dataset. This includes 670 Clovis, 384 Cumberland, and 255 Dalton bifaces. The apparent reduction over time in the frequencies of biface types has been used to argue for a reduction in regional populations (Anderson et al. 2011). However, the reduction in biface frequencies could also be a factor of unequal periods of time corresponding to the use of each technology. In the absence of a robust radiocarbon-based chronology for Paleoindian technologies, it is difficult to determine what factors are driving the changes in biface frequencies. Until better temporal control is established for regional Paleoindian chronologies, it will be difficult to say with any degree of certainty whether differences in biface frequencies represent demographic changes, or if they are simply related to unequal temporal scales. As such, patterns in technological organization, land-use strategies, and toolstone selection may provide additional insight into behavioral changes in late Pleistocene populations in the region.

3.1. *Technological organization*

Summary statistics for morphological attributes are presented in Table 1. The most standardized attributes of all biface types are associated with the basal element, and presumably relate to hafting. The exception to this, however, is the depth of basal concavity. This is by far the most variable attribute across all three biface types. Relatively high variability in basal concavity has previously been documented in Paleoindian bifaces (Bever and Meltzer 2007; Deller and Ellis 1992; Smallwood 2012; Taylor-Montoya 2007).

Table 2 shows the results of Pearson's correlations between length and width for complete specimens, and Figures 2–4 present the corresponding scatter plots. Clovis ($r = 0.609$; $P < 0.001$) and Cumberland ($r = 0.570$; $P < 0.001$) have similar positive correlations, suggesting very similar reduction trajectories, presumably as a result of similar life histories. In contrast, there is no correlation in the length and width of Dalton ($r = -0.089$; $P = 0.185$). The lack of correlation in Dalton suggests that these bifaces were subjected to markedly different reduction trajectories.

Comparing the overall conditions of Clovis, Cumberland, and Dalton bifaces further reveals significant differences (Table 3). 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 suggests that either Dalton bifaces broke at a much lower frequency, or that broken bifaces were typically refurbished back into functional tools prior to discard.

3.2. *Land use*

Plotting biface frequencies by county reveals visible patterns in statewide distributions (Figure 5). The Cumberland Mountains are the only physiographic region where Paleoindian bifaces have not been

Table 1
Descriptive statistics for morphological measurements of Paleoindian bifaces

Biface assignment	Statistics	Maximum length (mm)	Basal width (mm)	Body width (mm)	Basal concavity:basal width	Maximum thickness (mm)
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

Table 2
Results of Pearson's correlations between length and body width

Biface assignment	*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

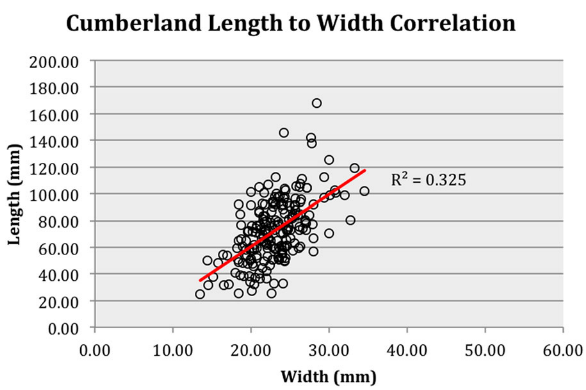

Figure 2 Plot of Cumberland length versus body width for complete bifaces from Tennessee (n = 204).

documented; it is omitted in additional analyses. Higher densities of bifaces of all types are generally located near the Highland Rim in the center of the state and along the lower Tennessee River. Two counties exhibit markedly denser concentrations than the rest of the state: Benton and Humphreys counties border the confluence of the lower Tennessee and Duck rivers. The exceptionally high biface densities in these counties warrants 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

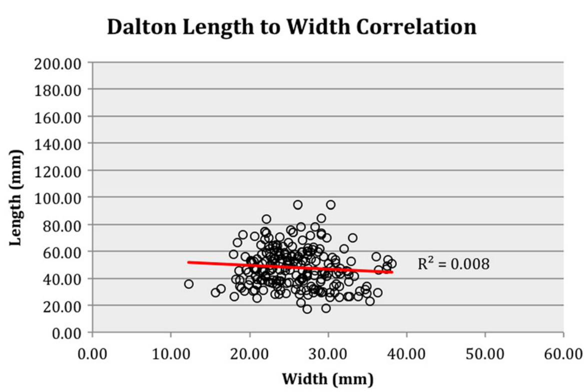

Figure 3 Plot of Dalton length versus body width for complete bifaces from Tennessee (n = 226).

are documented at the intersections of rivers, ecotones, and lithic sources, and may reflect land-use strategies rather than collection biases (Miller 2011).

The frequencies of bifaces by physiographic region further illustrate patterns in biface distributions (Figure 6). The majority of all bifaces occurs in the Highland Rim (62.9 per cent). The Coastal Plain (18 per cent) has the next highest frequency, closely followed by the Central Basin (11.8 per cent). The Ridge and Valley, Cumberland Plateau, Blue Ridge Mountains, and Alluvial Plain have much smaller frequencies, cumulatively totaling 7.5 per cent of all bifaces.

To further interpret Paleoindian land use, the densities of bifaces were scaled to account for differing sizes of the physiographic regions (Table 4). The highest density of bifaces occurs with Clovis in the Highland Rim at 11.92 bifaces per 1000 km^2, followed by the Central Basin (7.49 per 1000 km^2), and Coastal Plain (6.62 per 1000 km^2). A similar pattern is evident in Cumberland and Dalton. Cumberland bifaces occur essentially in equal densities in the Highland Rim (7.23 per 1000 km^2) and Central Basin (7.08 per 1000 km^2), followed by the Coastal Plain (1.82 per 1000 km^2) and Cumberland Plateau (1.32 per 1000 km^2). Dalton occurs in the highest density in the Highland Rim (5.75 per 1000 km^2), followed by the Coastal Plain (1.73 per 1000 km^2) and the Central Basin (1.23 per 1000 km^2). All biface types occur in very low densities (less than 1.00 per 1000 km^2) in the Alluvial Plain and Blue Ridge Mountains.

While comparing frequencies of biface types by physiographic regions reveals interesting patterns, comparing percentages of bifaces by physiographic regions provides additional information related to potential territory sizes (Table 5). Approximately 90 per cent of Clovis bifaces occur in the Highland Rim (58.5 per cent), Coastal Plain (22.8 per cent), and Central Basin (10.9 per cent). A similar distribution exists for Cumberland, which is approximately 90 per cent in the same regions: Highland Rim (62.2 per cent), Central Basin (18.0 per cent), and Coastal Plain (10.9 per cent). There is a distinctly different distribution in Dalton, which is densely concentrated in a smaller geographic area. Approximately 90 per cent of Dalton bifaces occur in the Highland Rim (74.5 per cent) and Coastal Plain (15.7 per cent). This pattern suggests that territories were becoming increasingly constricted throughout the Pleistocene to Holocene transition.

3.3. *Toolstone selection*

Fort Payne and St. Louis cherts are by far the dominant materials throughout all three biface types (Table 6 and Figures 7–9). Clovis bifaces made from both chert types occur at near-expected frequencies,

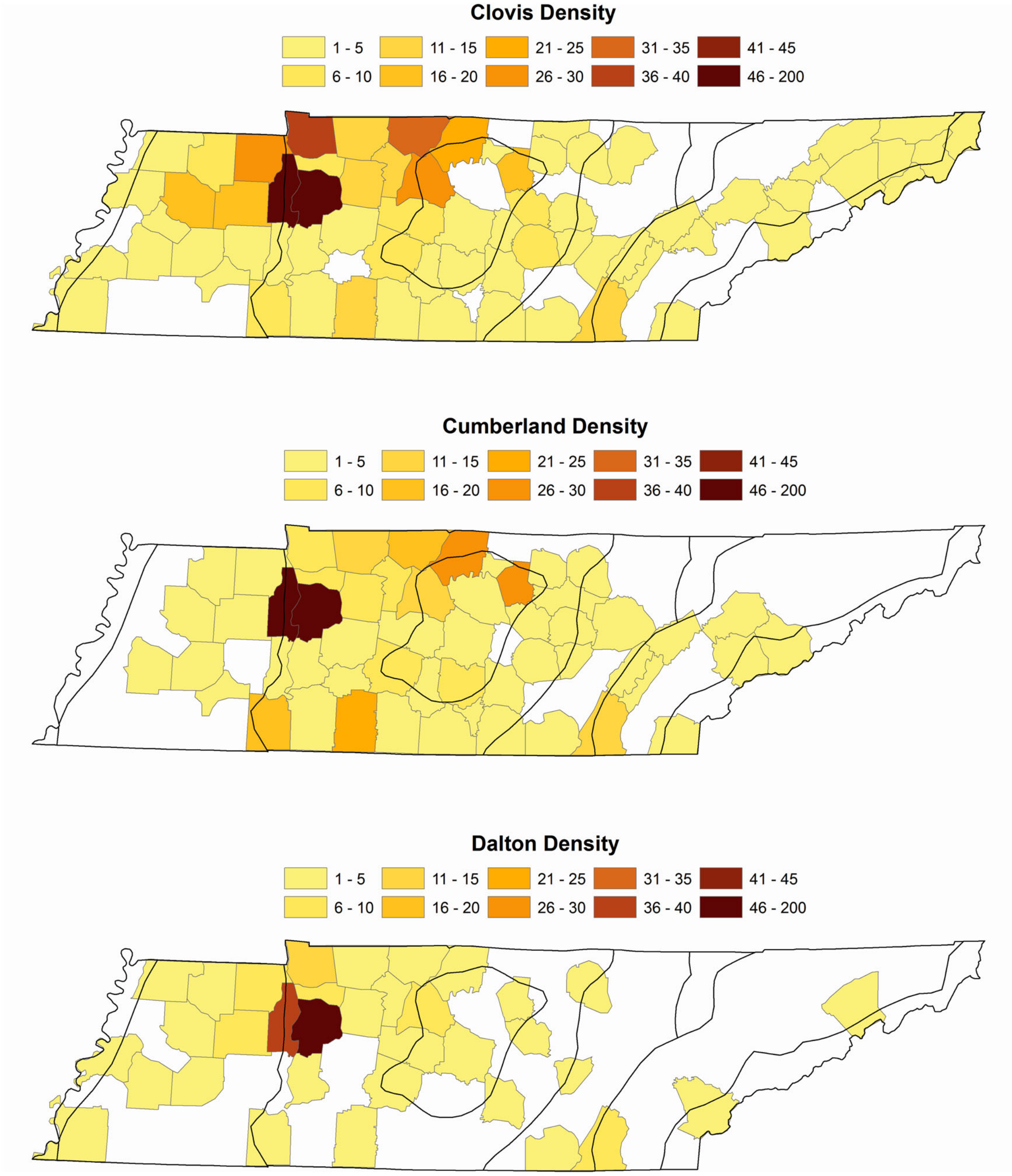

Figure 4 Density maps for each biface type showing frequencies by county and physiographic region.

suggesting that Clovis knappers used both materials evenly. The Cumberland and Dalton assemblages, however, demonstrate significantly different patterns ($x^2 = 81.65$; $df = 1$; $P < 0.001$). Cumberland knappers, on the one hand, preferentially selected Fort Payne chert, which occurs at a higher than expected frequency, while St. Louis occurs at a lower than expected frequency. 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 is skewed by two sites, which account for 61 per cent ($n = 103$) of the material. When those two sites are removed, Dalton toolstone use is more evenly distributed between Fort Payne (43 per cent) and St. Louis (50 per cent).

Table 3
Frequencies of bifaces used in this study by type and condition

Biface assignment	Complete, *n*	Basal fragment, *n*	Total	Ratio
Clovis	347	323	670	1.07
Cumberland	204	180	384	1.13
Dalton	226	29	255	7.79

While materials other than Fort Payne and St. Louis only comprise a small portion of the overall dataset (5 per cent), a notable pattern exists. Other materials occur at, or below, expected frequencies and account for small amounts of Cumberland (2 per cent) and Dalton (4 per cent) materials. For the Clovis dataset, however, other materials occur at a higher than expected

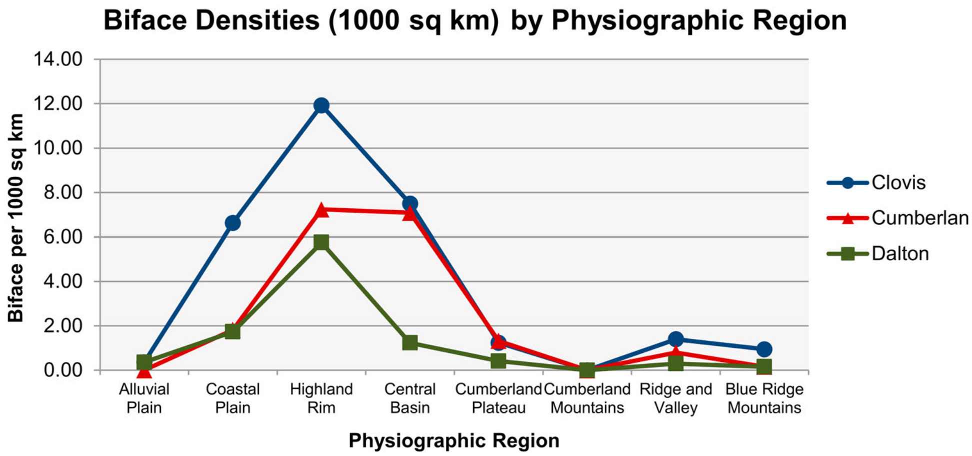

Figure 5 Line graph of biface densities in each physiographic region by biface type, per 1,000 km^2.

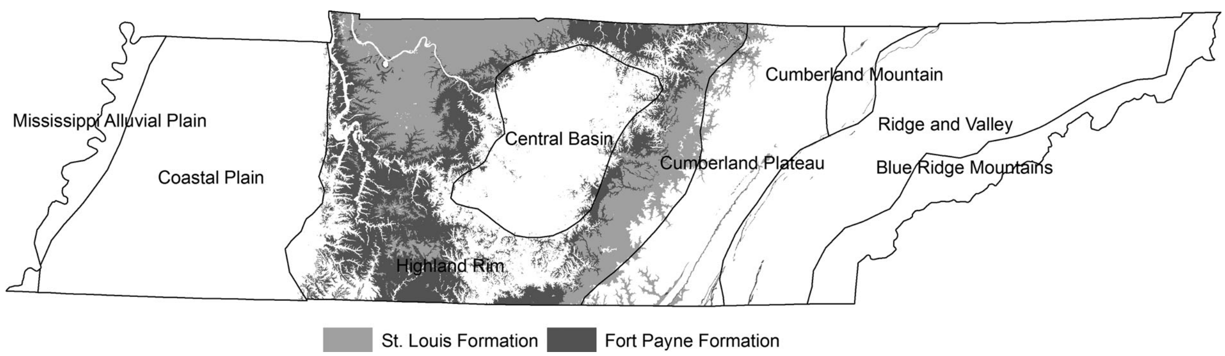

Figure 6 Physiographic regions and major chert-bearing geologic formations in Tennessee.

Table 4
Biface densities per 1000 km^2 for each physiographic region of Tennessee

Physiographic region	Area (km^2)	Clovis (per 1000 km^2)	Cumberland (per 1000 km^2)	Dalton (per 1000 km^2)	Total (per 1000 km^2)
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	20,066	1.40	0.80	0.30	2.49
Blue Ridge Mountains	6,372	0.94	0.16	0.16	1.26
Total	109,147	29.98	18.41	9.94	58.33

Table 5
Absolute counts and percentages of bifaces for each physiographic region of Tennessee

Physiographic region	Clovis	Cumberland	Dalton	Total
Alluvial Plain	1 (0.2%)	0 (0.0%)	1 (0.4%)	2 (0.2%)
Coastal Plain	153 (22.8%)	42 (10.9%)	40 (15.7%)	235 (18.0%)
Highland Rim	394 (58.8%)	239 (62.2%)	190 (74.5%)	823 (62.9%)
Central Basin	73 (10.9%)	69 (18.0%)	12 (4.7%)	154 (11.8%)
Cumberland Plateau	15 (2.2%)	16 (4.2%)	5 (2.0%)	36 (2.8%)
Cumberland Mountains	0 (0.00%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Ridge and Valley	28 (4.2%)	16 (4.2%)	6 (2.4%)	50 (3.8%)
Blue Ridge Mountains	6 (0.9%)	6 (0.5%)	1 (0.4%)	9 (0.7%)
Total	670 (100%)	384 (100%)	255 (100%)	1309

Table 6
Counts and percentages of bifaces by type and raw material

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

frequency and account for 8 per cent of Clovis material. The greater diversity of toolstone used by Clovis knappers suggests that they were less focused on material types than later Paleoindian knappers. This may indicate less familiarity with the local lithic landscape, as well as a larger territorial range related to early colonizers. In contrast, Cumberland and Dalton knappers were presumably more familiar with locally available material sources. This pattern may further suggest that Cumberland and Dalton populations had relatively smaller territorial ranges than Clovis.

4. Discussion

Anderson et al. (2011; Meeks and Anderson 2012) contend that a reduction in the frequency of

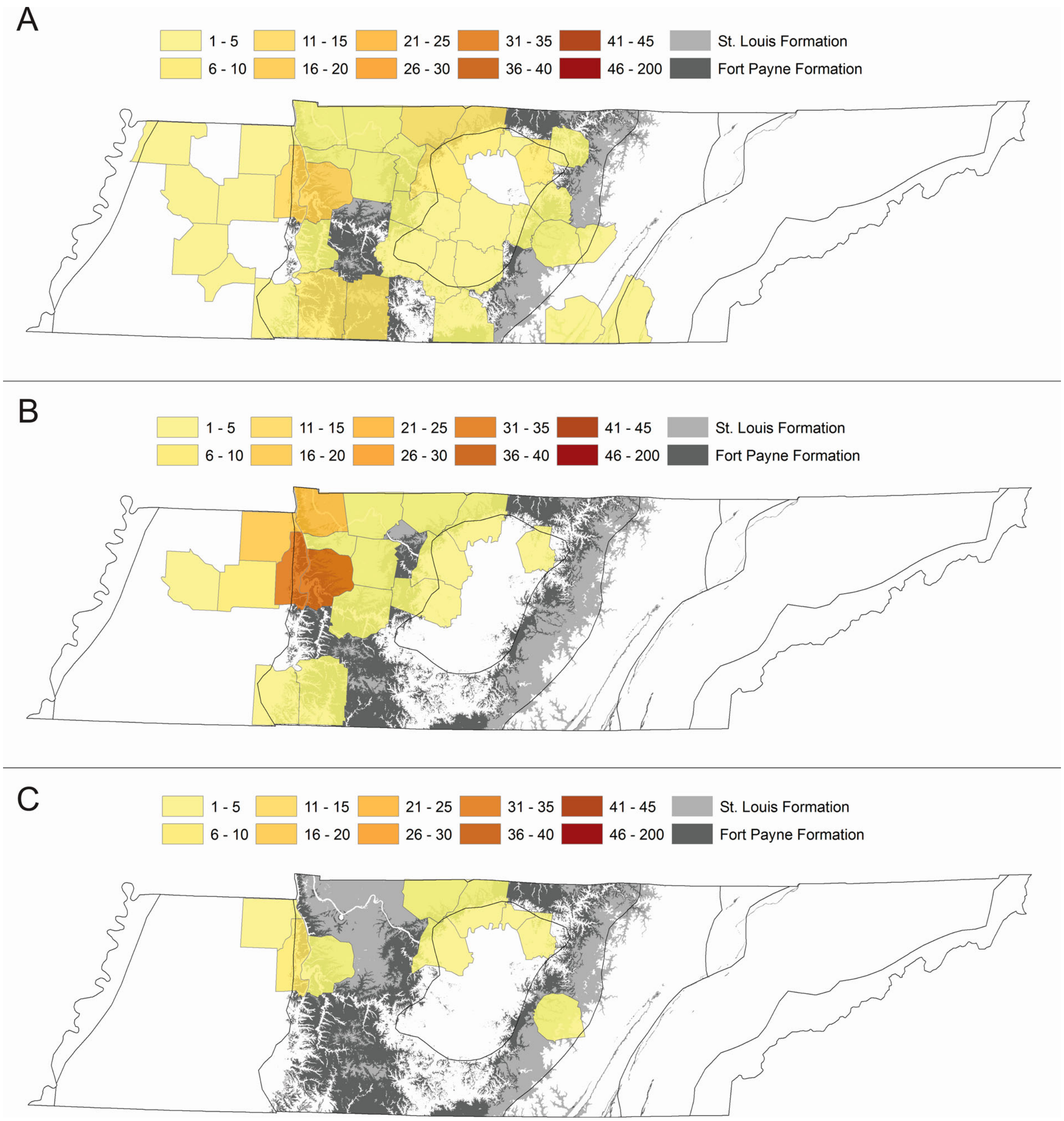

Figure 7 Distribution of Clovis bifaces by raw material type: (A) Fort Payne; (B) St. Louis; (C) other.

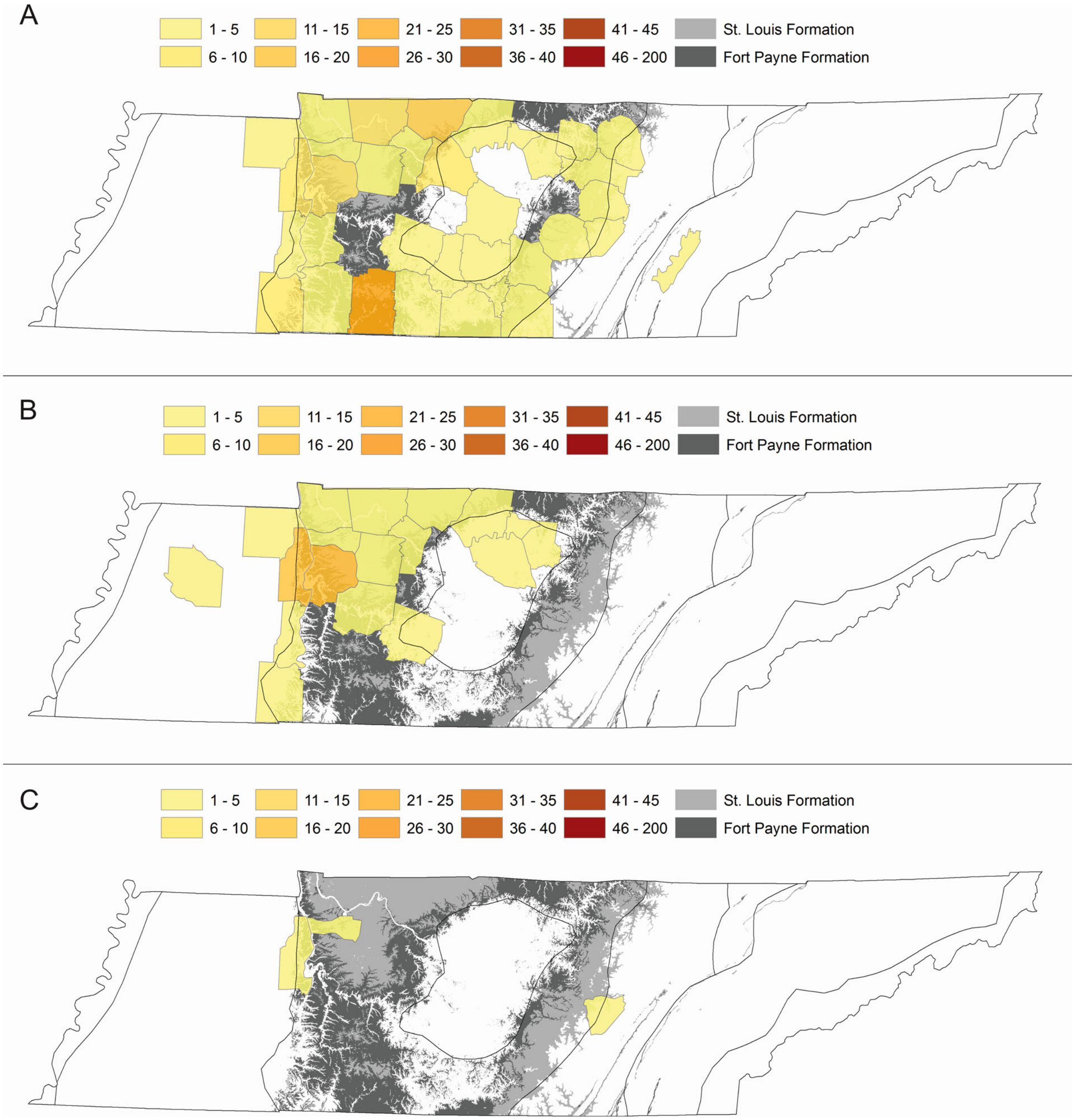

Figure 8 **Distribution of Cumberland bifaces by raw material type: (A) Fort Payne; (B) St. Louis; (C) other.**

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 support this hypothesis (Smallwood et al. 2015), such a pattern is not reflected in the data from the Midsouth. Rather, there is a continual decline in the frequencies of bifaces 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 during the YD. Behavioral adaptations in the Midsouth are characterized by increasing regionalization and a greater emphasis on local resources. Throughout the Clovis–Cumberland–Dalton succession, 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, and complete-to-broken ratios of approximately one-to-one. This pattern suggests similar life histories for the bifaces, and indicates that when Clovis and Cumberland 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 ratio of nearly eight-to-one. The lack of correlation indicates that Dalton bifaces were

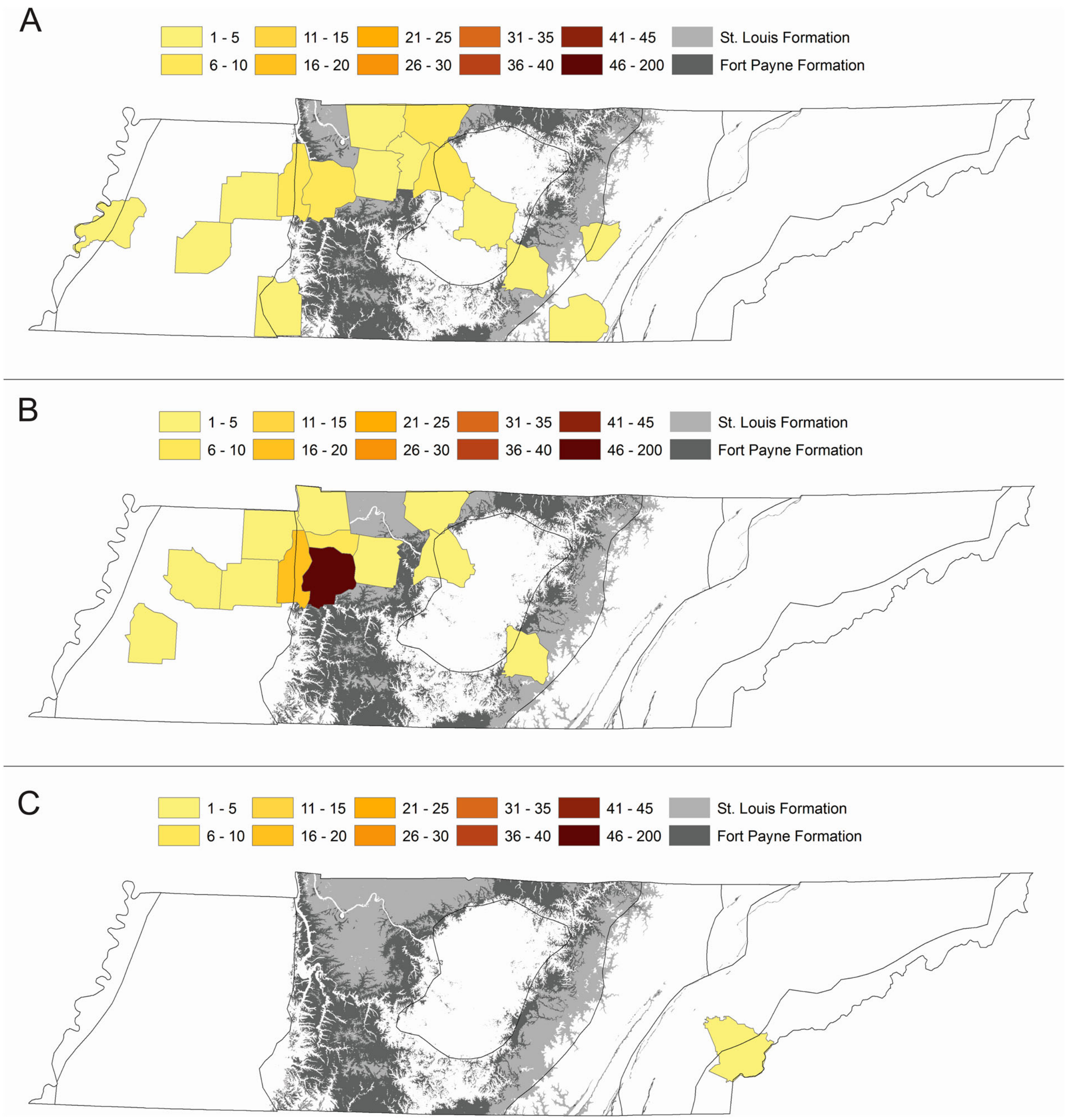

Figure 9 Distribution of Dalton bifaces by raw material type: (A) Fort Payne; (B) St. Louis; (C) other.

heavily reworked to extend their use-lives. This is not unexpected given the results of previous studies modeling expended utility in Dalton assemblages (e.g., Goodyear 1974; Shott and Ballenger 2007).

Considering potential relationships between changes in land use and paleoecology may further explain the transition 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 have led 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 for raw materials.

A second, and complementary, 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 reflect 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 by the beginning of 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. This overall pattern suggests that landscape learning was occurring throughout the Clovis–Cumberland–Dalton succession as people were continuing to settle in to the region. Increased familiarity with local resource distributions likely led to more localized resource acquisition. The relative proportions of each biface type by physiographic region suggest that the Highland Rim played an increasingly important role in regional land-use strategies. By the end of the Clovis–Cumberland–Dalton succession, three-fourths of Dalton bifaces were being discarded in the Highland Rim.

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 a greater variety of raw materials than 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 region. 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 9). 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. Koldehoff and Walthall (2009) identified a very similar pattern in the central Mississippi River valley.

5. Conclusion

To assess the effects YD related paleoecological conditions had on human behavioral adaptations in the Midsouth, I investigated changes in technological organization, land 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. 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 led to substantial reorganization of technologies in the Midsouth. Rather, data indicate a significant change occurred near the end of the YD. While the overall frequency of Cumberland bifaces dramatically declined immediately following Clovis near 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 frequencies of bifaces throughout the Pleistocene to Holocene transition. Biface technologies trended toward longer use lives with significantly different reduction strategies. Bounded territories appear to have become more rigid and increasingly restricted from Clovis to Cumberland to Dalton, while toolstone selection became more focused on locally available sources. Regionalization associated with settling in processes may explain long-term changes in human behavioral adaptations in the Midsouth. The overall patterns in technological organization, land use, and toolstone selection reflect a trend of increasing regionalization that began to develop with Clovis and was well-established by Dalton.

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