END SCRAPER MORPHOLOGY AND USE-LIFE: AN APPROACH FOR STUDYING PALEOINDIAN LITHIC TECHNOLOGY AND MOBILITY

Juliet E. Morrow

ABSTRACT

Kelly and Todd (1988) proposed that bifaces served as transported cores within the lithic technology of Early Paleoindian groups. This concept is evaluated here through an analysis of end scrapers from three sites, two located in west-central Illinois and one in eastern Missouri. If transported bifacial cores served as the source for flake blanks used to make end scrapers, the morphology of these tools should change with increasing distance from raw material source areas. Specifically, end scrapers made from raw materials that were far removed from their respective source areas should be smaller and especially thinner than end scrapers made of the same materials found closer to the source area, and these end scrapers should exhibit a higher frequency of bifacial striking platforms reflecting the increased use of bifaces as a flake blank source. Further, end scrapers made of raw materials that were transported greater distances should not necessarily be more extensively resharpened than specimens found closer to the stone source. The results of this analysis lend some support to the idea that Early Paleoindians carried stone in the form of unfinished bifaces that served as cores for flake tools. However, a mixed strategy, perhaps involving the transport of unmodified flake blanks and/or finished end scrapers, along with bifaces, may better explain the patterns revealed.

INTRODUCTION

End scrapers are a common tool class in North American Paleoindian assemblages. This paper focuses on the analysis of end scrapers from three sites in the Mississippi-Missouri-Illinois Rivers confluence area. The analysis examines patterns of end scraper manufacture and maintenance with respect to the raw materials represented and their relative distances from these sites. Attributes recorded from these end scrapers will be used to evaluate the potential role of bifaces as transported cores within Early Paleoindian lithic technology (c.f. Kelly and Todd 1988).

THE ORGANIZATION OF EARLY PALEOINDIAN LITHIC TECHNOLOGY

Early Paleoindian settlement and land-use are typically characterized as highly mobile, although the various facets of mobility (e.g., frequency between moves, distance between moves, composition of group doing the moving) are seldom made explicit. While conceptually important, these facets of mobility are not readily discernible from the archaeological record -- particularly when one is dealing with an incomplete sample of sites that are individually rarely well-preserved and that include at least some sites that were periodically reoccupied. With specific reference to the present study area, it is noted that 1) Early Paleoindian artifacts occur in small site contexts, as well as large site contexts which may represent palimpsests or aggregates; and 2) the frequency of nonlocal lithic raw materials and the average distances away from parent source areas that raw materials were moved are greater in Early Paleoindian assemblages than in post-Early Paleoindian assemblages.

Paleoindian lithic assemblages are commonly dominated by tools and manufacturing debris made of high-quality lithic raw materials that have limited source distribution. Paleoindian subsistence and mobility required a technology that could be relied upon in areas away from such high quality raw material sources. Tool kits had to

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be readily transportable while, at the same time, tool use-life had to be maximized so that serviceable equipment would be available away from lithic raw material sources. Kelly and Todd (1988:237) suggested that:

> If Paleoindians were residentially and logistically mobile, and shifted their range frequently, they would have needed a highly portable technology which could fulfill all tool needs, including terrestrial game hunting. It is not surprising then, that Paleoindian assemblages contain many bifaces. If made from a high quality raw material, bifaces can have a fairly sharp but durable edge that can be resharpened repeatedly, and from which flakes can be removed for expedient use. More usable flake edge can be produced from a biface than from a simple casual core of similar weight because a biface reduction flake has a high edge:weight ratio. Thus, bifaces maximize the number of tools while minimizing the amount of stone carried -- a necessity for a highly mobile people.

If, as Kelly and Todd (1988) suggested, Early Paleoindian groups transported lithic raw material in the form of bifacial cores, then flake blanks used for the production of end scrapers should vary in morphology with increasing distance away from raw material sources: (1) they should exhibit a higher percentage of bifacial striking platforms, thus reflecting the edge characteristics of the parent bifacial core form; (2) they should exhibit general declines in some dimensions, especially in thickness, reflecting the smaller and thinner flake blank forms yielded from bifaces undergoing continued reduction; and (3) end scrapers made of raw materials far removed from their respective source areas should not necessarily be more extensively resharpened, or exhausted, than end scrapers made of the same materials found closer to the source areas.

PALEOINDIAN END SCRAPERS DEFINED

Paleoindian end scrapers are unifacially flaked tools made from a flake blank. Within Paleoindian lithic assemblages these flake blanks could have been struck from block cores, blade cores, or bifacial cores. The striking platform, or proximal, end, of the flake blank generally forms the proximal, or "butt," end of the tool and the distal end of the flake blank generally forms the distal "bit," or working end. Paleoindian end scrapers may have spurs on one or both of the lateral margins where they intersect the working edge. Unifacial end scrapers have long been considered diagnostic of the Paleoindian period (Judge 1973). They occur in fluted (Clovis and Folsom) and unfluted lanceolate (Plainview, Agate Basin, Hell Gap, Alberta/Cody) Paleoindian complexes of the western U.S. (Irwin and Wormington 1970; Judge 1973; Wilmsen and Roberts 1978; Frison 1991), as well as in Middle and Late Paleoindian complexes in the Great Lakes region (Deller and Ellis 1988; Ellis and Deller 1988) and in assemblages dating to the late Pleistocene/early Holocene in Alaska (Goebel et al. 1991). Some researchers treat Paleoindian end scrapers as a single morphological type or class with functional significance (e.g., Ellis and Deller 1988; Shott 1995), while others treat them as a variety of tool within a broader tool class (e.g., Hester 1972). Many researchers hypothesize that Paleoindian end scrapers served as hide working tools (see Shott 1995:41), but evidence in the form of use-wear, residues, etc., which would confirm this hypothesis is generally lacking. A limited number of studies of end scraper (or similar tool forms) use-wear and/or use-life have been published (e.g., Brink 1978; Grimes and Grimes 1985; Marshall 1985; Schultz 1992), but more studies are needed, especially those that compare experimental and archaeological data sets (e.g., Schultz 1992).

END SCRAPER ATTRIBUTES RECORDED

In the study that follows, it was necessary to inspect specific attributes of Paleoindian end scrapers in order to investigate the questions being asked of the data. Metric attributes measured with sliding Vernier calipers to the nearest tenth of a millimeter include Maximum Length (ML), Maximum Width (MW), Maximum Thickness (MT), and Working Edge Convexity (WEC) (Figure 1). Working Edge Angle is recorded in degrees using a contact goniometer. Morphological attributes recorded for end scrapers include Outline Morphology (ESM) (Figure 2) and Striking Platform Morphology (SPM) (Figure 3). Other non-metric variables recorded include Lithic Raw Material (RM) and Heating State (HS). Attributes are defined as follows:

Maximum Length (ML): the length along the centerline of the tool from the proximal end to the most distal point of the distal or working edge.

Maximum Width (MW): the maximum width of the tool, perpendicular to maximum length.

Maximum Thickness (MT): the maximum thickness of the tool, wherever it occurs.

Working Edge Convexity (WEC): the length between the corners of the working edge and the most distal point on the bit of the tool.

Working Edge Angle (EA): the average of three angle measurements of the working edge. This measurement corresponds to the angle formed between the unretouched ventral face of the end scraper and the retouched dorsal working edge and is equivalent to the attribute of Retouch Angle recorded by Shott (1993:50).

Outline Morphology (ESM): one of five arbitrary morphological categories which define the outline shape of the end scraper. These categories are intended to subdivide what is essentially a continuum of outline shape. They do not represent distinct end scraper "types."

Triangular: the width of the proximal end is less than 1/2 the width of the distal end.

Tapered: the width of the proximal end is greater than 1/2 the width of the distal end.

Parallel-sided: the width of the proximal end is approximately the width of the distal end.

Convergent: the proximal end is the widest part of the tool.

Ovate Double-ended: the greatest width is at mid-portion, with working edges on both the proximal and distal ends of the tool.

Irregular: any shape that does not fit into the other five categories.

Striking Platform Morphology (SPM): the presence/absence of cortex and the number of facets in direct contact with the striking platform edge, if preserved from the original flake blank from which the end scraper was made. These categories are better referred to as "proximal flake edge modification" categories, because prior flaking scars on both the ventral and dorsal edge of the flake are considered (see T. Morrow, this volume):

Cortical: where the striking platform of a flake or tool is covered by natural, nodular or weathered cobble, cortex.

Simple: only one or two facets are present on the dorsal and/or ventral faces of the platform. *Unifacial Ventral*: three or more facets are present on the ventral face of the platform, two or less on the dorsal face of the platform.

Unifacial Dorsal: three or more facets are present on the dorsal face of the platform, two or less on the ventral face of the platform.

Bifacial: three or more facets are present on both the ventral and dorsal faces of the platform.

All lithic raw material identifications were made using a primarily macroscopic method involving comparisons between archaeological specimens and chert samples from outcrop formations of known geological age/formation. A 10x hand lens was occasionally used to identify fossil and/or mineral inclusions. Multiple attributes (especially presence/absence of fossil and mineral inclusions, presence/absence of banding and mottling patterns, translucency, and luster) can generally be used to distinguish many of the chert types which occur on prehistoric sites in the study area. Heating state of raw material was determined by the luster, color, and presence/absence of heat-induced features such as potlid fractures and crazing.

END SCRAPER SAMPLE SELECTION

Metric, morphological, and lithic raw material data were recorded on a total of 132 end scrapers from the Bostrom site, 11S1062 (Figure 4), east of St. Louis (Tankersley et al. 1993; Tankersley and Morrow 1993; Tankersley 1995); 85 end scrapers from the Ready/Lincoln Hills site, 11JY46 (Figure 5), north of St. Louis at the confluence of the Illinois and Mississippi Rivers (Morrow and Morrow 1993, Tankersley and Morrow 1993; J.E. Morrow 1995), and 12 end scrapers from the Martens site, 23SL222 (Figure 6) west of St. Louis, Missouri (Koldehoff et al. n.d.). All three sites are located in upland settings (Figure 7). The Ready/Lincoln Hills site, a large multicomponent quarry workshop/habitation, and the Martens site, a large multicomponent habitation, are both within several kilometers of high-quality lithic resources. The Bostrom site is also a large multicomponent habitation site, but one that is located more than 60 km from any high-quality lithic resources. Multiple fluted points have been recovered from each of these sites, the vast majority of them representative of the Clovis type (Table 1; see J.E. Morrow 1995).

Because of the multicomponent nature of these sites, it was necessary to "purify" the end scraper

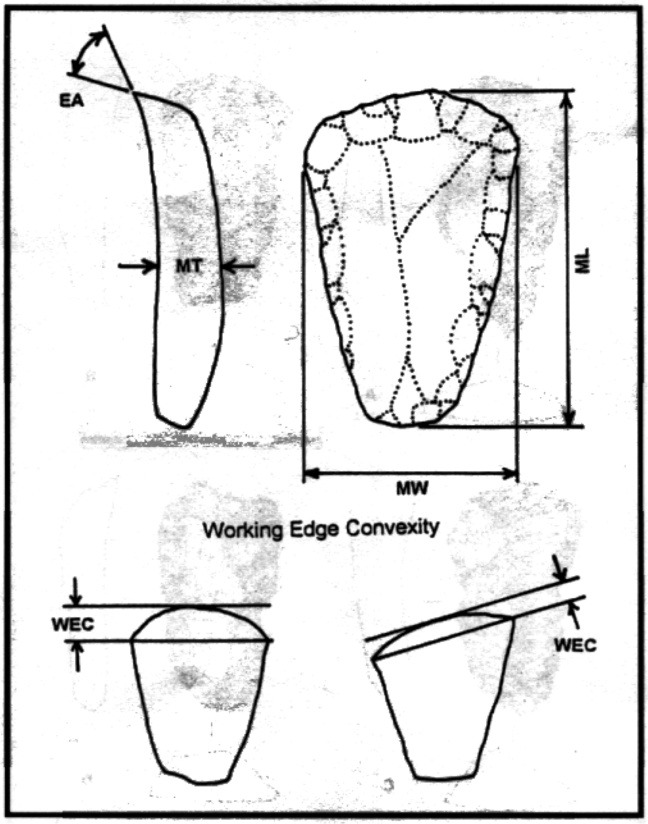

Figure 1. Metric Attributes recorded on end scrapers; EA = Edge Angle, MT = Maximum Thickness, MNL = Max. Length, MW = Max. Width, WEC = Working Edge Convexity.

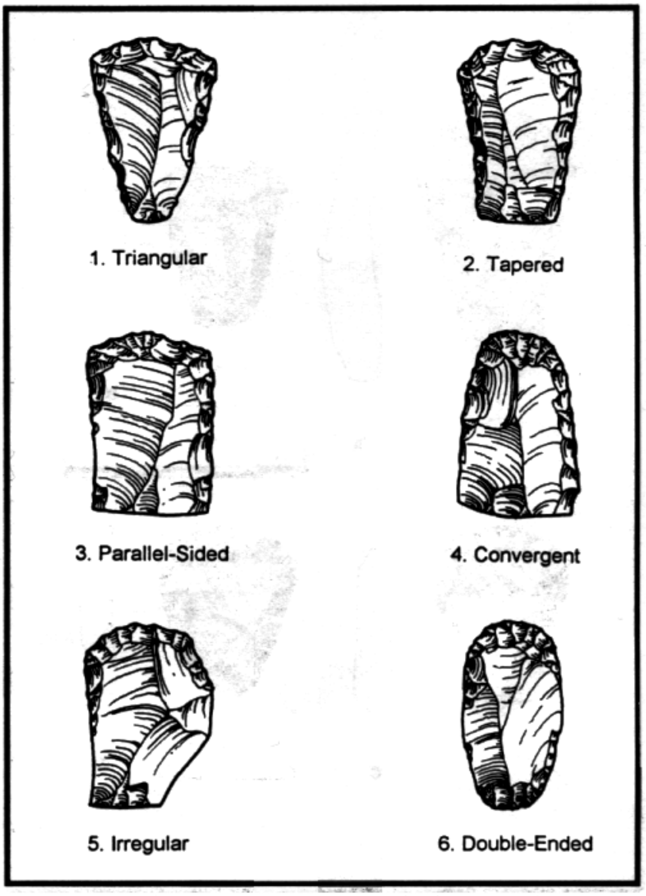

Figure 2. End scraper outline morphologies.

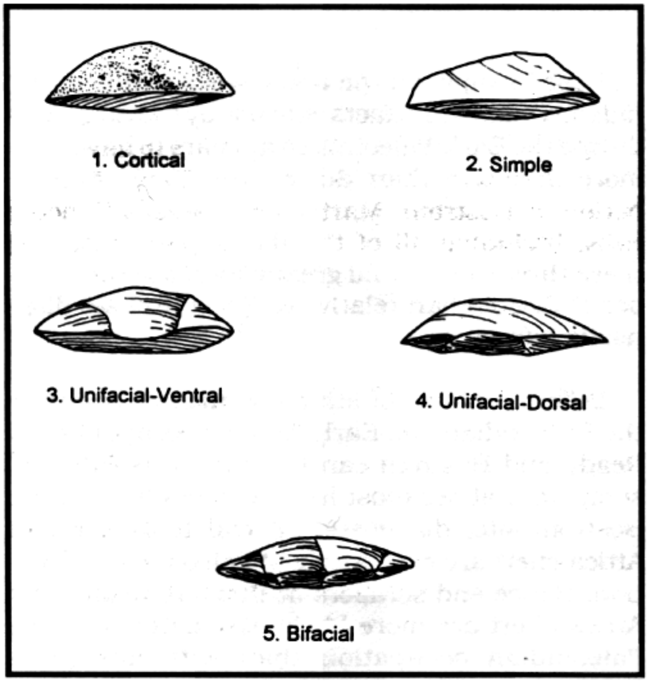

Figure 3. Striking Platform categories.

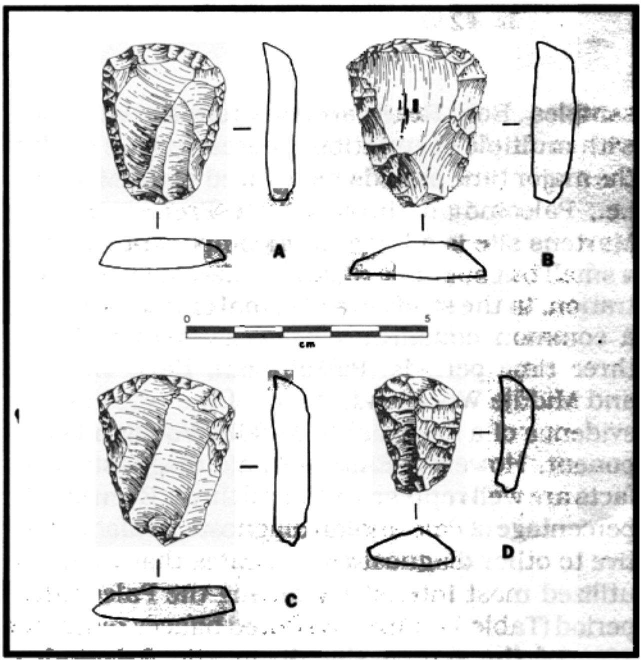

Figure 4. Bostrom site end scrapers; A. #37; B. #77, Burlington Chert; C. #620, Burlington Chert; and D. # 84, Attica Chert.

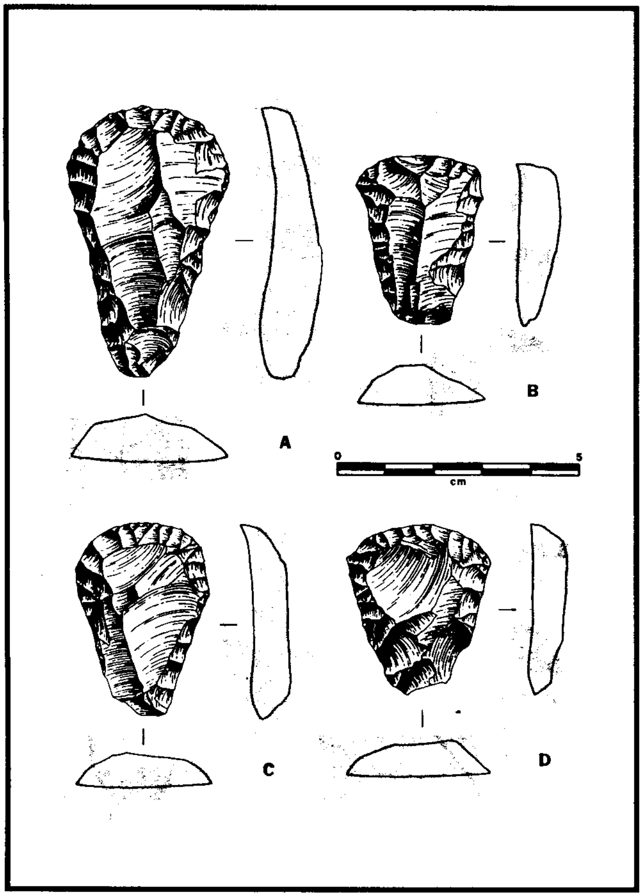

Figure 5. Ready/Lincoln Hills site, Burlington chert end scrapers: A. #203; B. # 127; C. #620; and D. #202.

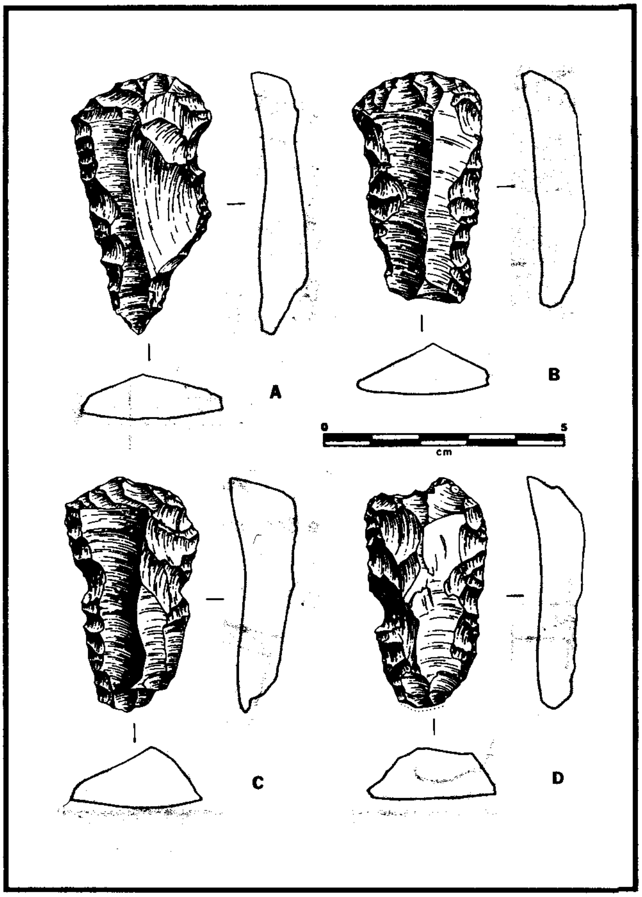

Figure 6. Martens site, Burlington chert end scrapers: A. #121; B. #192; C. #193; D. #194.

samples. Both Ready and Bostrom are large sites with multiple occupations representative of all of the major time periods recognized in the Midwest, i.e., Paleoindian through Late Prehistoric. The Martens site is a large multicomponent site with a small but spatially distinct Paleoindian concentration. In the study area, formal end scrapers are a common constituent of assemblages of only three time periods: Paleoindian, Early Archaic, and Middle Woodland. None of the sites exhibit evidence of a substantial Middle Woodland component. However, Early Archaic diagnostic artifacts are well represented at all three. Even so, the percentage of Paleoindian diagnostic artifacts relative to other diagnostics indicates that each was utilized most intensively during the Paleoindian period (Table 1). Finished fluted bifaces represent 70% of the temporally diagnostic Paleoindian through Early Archaic biface assemblage from the Ready site, 70% of the Bostrom assemblage, and 80% of the Martens assemblage.

Based simply on the abundance of diagnostic *finished* bifacial artifacts, site use by Clovis groups during the Early Paleoindian appears to have been more intensive than during the Early Archaic period at Bostrom, Martens and Ready/Lincoln Hills. Including all of the fluted preforms from these three sites would greatly increase the number of Paleoindian relative to Early Archaic diagnostic bifaces.

Differential use of lithic raw materials during the Paleoindian and Early Archaic occupations of Ready and Bostrom can be used to isolate end scrapers that are most likely Paleoindian. At the Bostrom site, diagnostic bifacial tools made of Attica chert are exclusively of Paleoindian affiliation. Hence end scrapers at this site made from Attica chert are more likely associated with the Paleoindian occupation than with any post-Paleoindian occupation. The same procedure can be used to relate the Blair chert end scrapers from

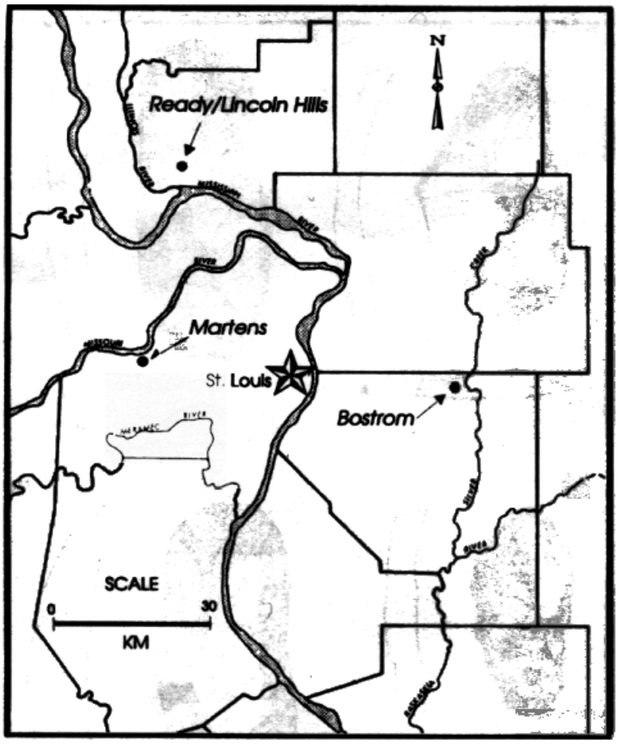

Figure 7. Map showing the locations of the study sites.

the Ready site to the Paleoindian component. Because all diagnostic bifaces (i.e., fluted points and preforms) made of Blair chert at the Ready site are Paleoindian, it is likely that less diagnostic tools (i.e., end scrapers) as well as manufacturing and maintenance by-products made of this material are also of Paleoindian affiliation. If Ready Blair and Bostrom Attica end scrapers are pooled, attribute ranges are: 17.8-51.6 mm for length, 16.3-32.1 mm for width, 3.6-11.9 mm for thickness, 45-95 degrees for working edge angle, and 2.0-9.0 for working edge convexity. Fifty-three percent of the Ready Blair and Bostrom Attica end scrapers exhibit a triangular outline morphology; 82 percent have angular or spurred corners.

No data have yet been published on end scrapers from a radiocarbon dated Paleoindian context located within or even near the study region. However, a lithic assemblage excavated from Horizon II (ca. 9400-9000 B.P., T.A. Morrow 1996) at the Twin Ditch site, located several miles north of the study area, provides baseline data on Early Archaic end scrapers (Table 2). Comparison of end scrapers from Horizon II of the Twin Ditch site with end scrapers made of Attica chert from the Bostrom site and those manufactured of Blair chert from the Ready site indicates that Early Archaic end scrapers differ markedly from Paleoindian end scrapers. Early Archaic end scrapers from the Twin Ditch site are large: they range in length from 40.0 to 102.7 mm, in width from 25.9 to 53.6 mm, and in thickness from 5.0 to 15.1 mm. Paleoindian end scrapers from Ready and Bostrom are comparatively smaller. The majority of Twin Ditch end scrapers exhibit either a tapered (29%), parallel-sided (21%), or irregular (21%) outline morphology, while the Paleoindian end scrapers are usually of triangular, or less often, tapered form. Early Archaic end scrapers are rarely triangular in outline (Figures 8 and 9).

It is noteworthy that the ovate, double-ended end scraper form is present in Horizon II at Twin Ditch, while ovate, double-ended scrapers are absent from both the Ready and Bostrom assemblages. Another attribute on which Paleoindian and Early Archaic end scrapers differ is the convexity of the working edge. Early Archaic end scrapers tend to exhibit relatively well-rounded (convex) working edges, while the working edges of Paleoindian end scrapers from Ready and Bostrom tend to be straighter and less convex. None of the end scrapers from Twin Ditch exhibit distinctly spurred corners and only 7% exhibit angular corners.

Based on the Bostrom Attica and Ready Blair end scraper assemblages, Paleoindian end scrapers are, in general, relatively small compared with Early Archaic end scrapers, and usually exhibit a triangular outline morphology (Table 3). Paleoindian end scrapers tend to be more extensively shaped than their Early Archaic counterparts. Consequently, Early Archaic end scrapers tend to more closely resemble the original flake blank on which they were made and thus exhibit a greater variety of outline morphologies. Paleoindian end scrapers often display marked angular corners or spurs where the lateral and working edges intersect. Whether these spurs were intentionally made to function as an additional tool such as a graver or constitute an irregularity resulting from resharpening remains to be addressed. In any case, angular or spurred corners are present on the vast majority of Blair chert end scrapers from the Ready site and Attica chert end scrapers from the Bostrom site. Of all the differences among these Paleoindian and Early Archaic end scrapers, outline morphology (triangular) and the presence of angular or spurred corners are the most prevalent. These two selec-

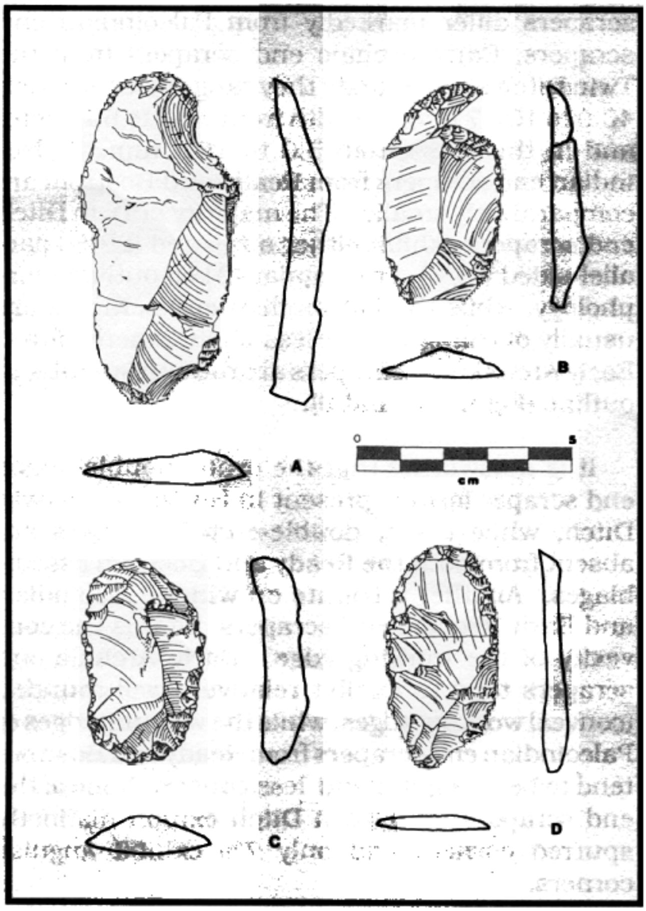

Figure 8. Twin Ditch, end scrapers: A. Square 12-10-4+, Burlington chert; B. Square 12-12-3+ Burlington chert; C. Square 24-09NW-15, unidentified chert; D. Square 12-12-6+, Burlington chert.

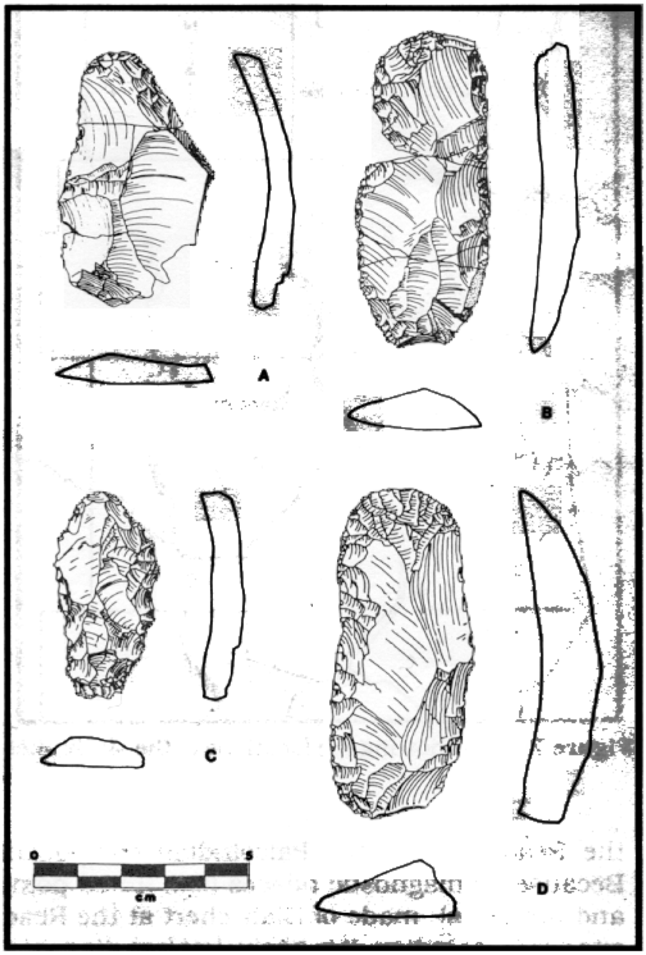

Figure 9. Twin Ditch, Burlington chert end scrapers: A. Square 2-21-6+; B. Square 8-12-3+; C. Square 8-12-6; D. Square 12-12-1.

tion criteria would eliminate about 85% of the Early Archaic end scrapers from the Twin Ditch sample, while retaining at least 90% of the Ready Blair and Bostrom Attica end scraper sample.

Because they exhibited neither triangular outline morphology nor angular or spurred corners, 11 specimens were eliminated from the Bostrom end scraper sample (4 Burlington, 3 Salem/St. Louis, 3 Cobden, 1 Ste. Genevieve) and 11 specimens (10 Burlington, 1 Munfordville) were eliminated from the Ready site sample. Based on the criteria outlined above, the remaining specimens are most likely associated with the sites' Paleoindian components.

Eleven of the twelve end scrapers from the Martens site are made of Burlington chert, have either triangular or tapered outline morphologies, and exhibit angular or spurred corners. Only one specimen does not meet either of these criteria and was not included in this analysis. It is a large, roughly parallel-sided, oval-end scraper made of Salem/St. Louis chert.

END SCRAPER MANUFACTURE AND FLAKE BLANK SOURCES

Experimental replications indicate that there is a strong correlation between striking platform morphology and core/blank form. For example, flakes derived from bifacial reduction exhibit a high incidence of bifacial striking platforms (T.A. Morrow, this volume). Unifacial dorsal platforms are commonly associated with blade core reduc-

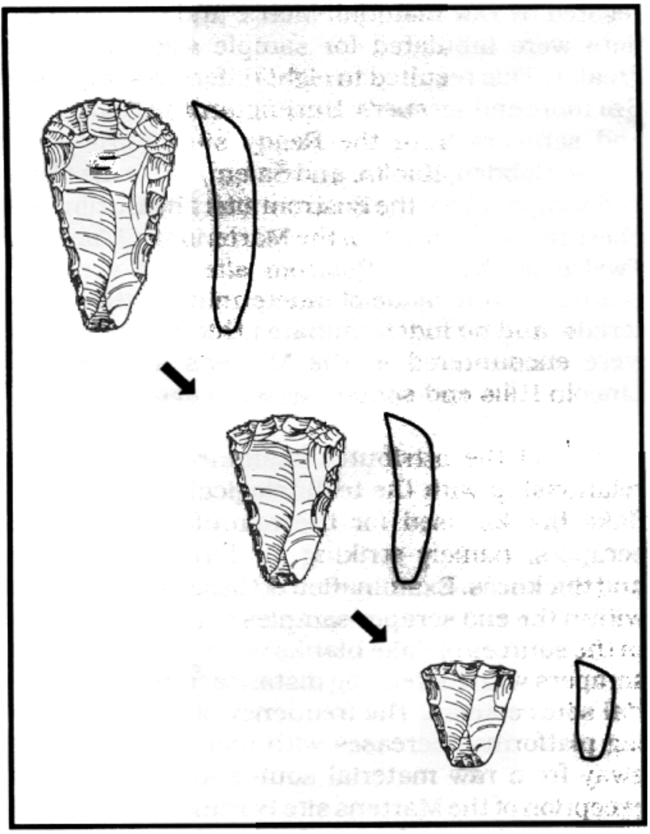

Figure 10. Model of changes in end scraper morphology with progressive resharpening.

tion, but can also be produced during bifacial core reduction. Together, unifacial dorsal and bifacial striking platforms are usually indicators of the later stages of core/biface reduction. The earlier stages of core reduction are often represented by cortical (if cortex is present on a given piece of lithic raw material), simple, and unifacial ventral striking platforms (T.A. Morrow, this volume). Replicative experiments have also shown that flakes derived from bifacial cores tend to be thinner on average than those derived from blade cores, particularly in the later stages of manufacture. In summary, the variation in flake blank source can be monitored fairly effectively by the attributes of maximum thickness and striking platform morphology.

If the technological sources of flake blanks for producing end scrapers changes with distance from raw material source such that bifaces are increasingly being used as cores for the production of flake tool blanks away from raw material sources, it follows that the incidence of bifacial striking platforms should increase with increasing distance from the raw material source. Thus, if transported bifacial cores of a given raw material were used to provide flake blanks for Paleoindian end scrapers, then end scrapers made on flakes from these bifacial cores would replace depleted end scrapers made on primary flakes with increasing distance from a given raw material source. In this case there should be a moderately strong correlation between distance and proportion of bifacial striking platforms and between distance and thickness within an end scraper assemblage. These patterns, if they exist, would support Kelly and Todd's (1988) model of bifaces as transported cores.

MODEL OF END SCRAPER USE-LIFE AND DEPLETION

There are a number of predictable changes in the size and shape of an end scraper during its use-life. In general, as an end scraper is subjected to repeated resharpenings there should be a marked decrease in maximum length. Because of their shape, end scrapers with a triangular or tapered outline morphology should also decrease in maximum width. In addition, the working edge convexity should decrease as the end scraper is depleted, because the end scraper is resharpened toward the haft end, which inhibits the creation of a rounded working edge. The last series of resharpenings may result in a straighter working edge (Figure 10). There are suggestions in the literature that working edge angle also increases over the use-life of an end scraper (Wilmsen 1970). Maximum thickness should be relatively unaffected by resharpening and use. In summary, with increasing resharpening, triangular and tapered end scrapers should become shorter, narrower, and less convex along the working edge.

Experimental data confirms these predicted metric changes in end scrapers (Table 4). Using soft hammer percussion or pressure flaking, Toby Morrow replicated three different triangular end scrapers of Burlington chert (designated Nos. 1, 2, and 3). Experimental end scrapers 1 and 3 were manufactured strictly by softhammer percussion, while end scraper 2 was manufactured using only pressure. These experimental end scrapers were hafted in a wooden handle, dulled by light raking across a piece of sandstone, resharpened by either soft hammer or pressure, and measured after each resharpening. Each end scraper was dulled and resharpened a total of 10 to 25 times, depending on its initial size. An average length of 2.00 mm was lost with each resharpening using soft hammer percussion, and just under 1.00 mm using pressure flaking. The handle began to noticeably inhibit the resharpening of an end scraper when it reached a length of about 35 to 30 mm, with 22 mm of the proximal end of the end scraper covered by the haft.

Morrow's experimental data indicate that, as end scrapers are resharpened, maximum length, maximum width, and working edge convexity decrease; thickness is relatively unaffected; and edge angle increases. Correlations between the number of resharpenings and the metric attributes of End Scraper 1 appear in Table 5.

If Paleoindians manufactured end scrapers at or near lithic raw material sources, transported them away, and subjected them to periodic use and resharpening, we can predict a strong negative correlation between distance from raw material source and maximum length, maximum width, and working edge convexity. As distance increases, these attributes should decrease. Based on the experimental model, there also should be a strong positive correlation between distance and edge angle, and little or no correlation between distance and maximum thickness.

Alternatively, if end scrapers were being produced on flake blanks derived from transported bifacial cores, use depletion would not necessarily correlate with distance from raw material source. The end scrapers made on such flake blanks might be, on average, shorter and possibly narrower than ones made on larger flake blanks derived from, for example, a block core. They would probably be considerably thinner, as well. Since thickness is not tremendously affected by resharpening, variation in this attribute should reflect blank form more than tool maintenance. Furthermore, since freshly made end scrapers would have been produced far from raw material source areas, there would be no discernible relationship between edge angle and distance from lithic source area.

ANALYSIS

End scraper samples from each site were segregated by raw material. Metric and morphologic data were tabulated for sample sizes of six or greater. This resulted in eight different samples of 6 or more end scrapers: Burlington and Blair chert end scrapers from the Ready site; Burlington, Attica, Cobden, Kaolin, and Salem/St. Louis chert end scrapers from the Bostrom site; and Burlington chert end scrapers from the Martens site (Table 6). Twelve of the 132 Bostrom site end scrapers examined were made of indeterminate lithic materials, and no indeterminate lithic raw materials were encountered in the Martens and Ready/Lincoln Hills end scraper assemblages.

Two of the attributes examined here bear a relationship with the technological source of the flake blanks used for the manufacture of end scrapers, namely striking platform morphology and thickness. Examination of these two attributes within the end scraper samples suggests changes in the sources of flake blanks used to produce end scrapers with increasing distance from raw material source areas. The frequency of cortical striking platforms decreases with increased distance away from raw material source areas. With the exception of the Martens site Burlington chert end scrapers, the incidence of bifacial striking platforms tends to increase with distance away from the raw material source. Correlations between distance and percentage of bifacial and cortical striking platforms are not statistically significant (Figures 11 and 12).

Overall, the analysis of striking platform morphology is problematic. Comparatively few (47%) of the Paleoindian end scrapers in the study samples retain striking platforms, thus limiting sample sizes and decreasing the reliability of the results. The occurrence of Attica chert end scrapers bearing simple striking platforms at the Bostrom site does, however, indicate that even at a distance of 260 km from the raw material source, some end scrapers made on more primary flake blank forms were retained in the assemblage transported to the site.

The problems inherent in the limited data pertaining to striking platform morphology are not so severe for thickness, which could be measured on all specimens. End scraper thickness is strongly negatively correlated with distance (Table 7; Figure 13). The maximum thickness of end scrapers decreases with increasing distance from lithic raw material source area. Since end scraper

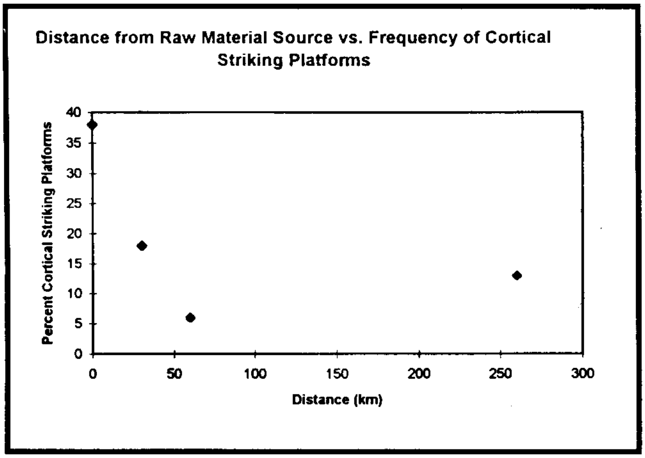

Figure 11. Distance from raw material source vs. frequency of cortical platforms.

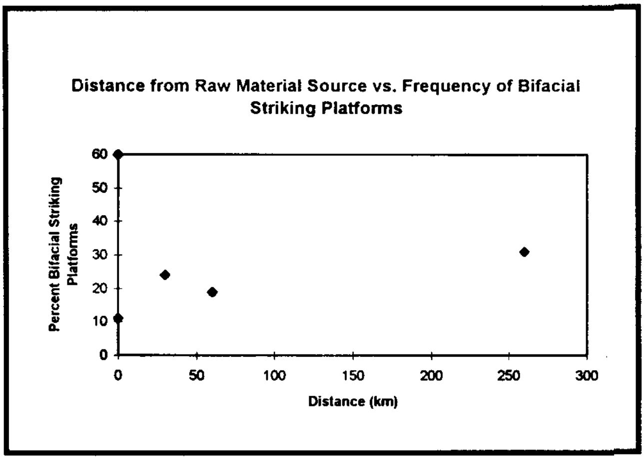

Figure 12. Distance from raw material source vs. frequency of bifacial striking platforms.

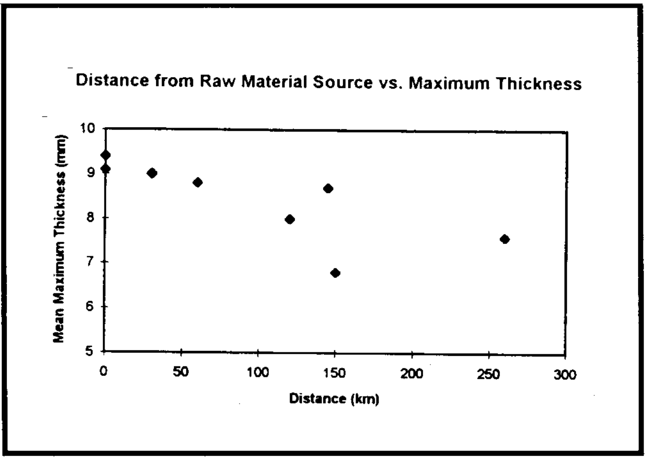

Figure 13. Distance from raw material source vs. maximum thickness.

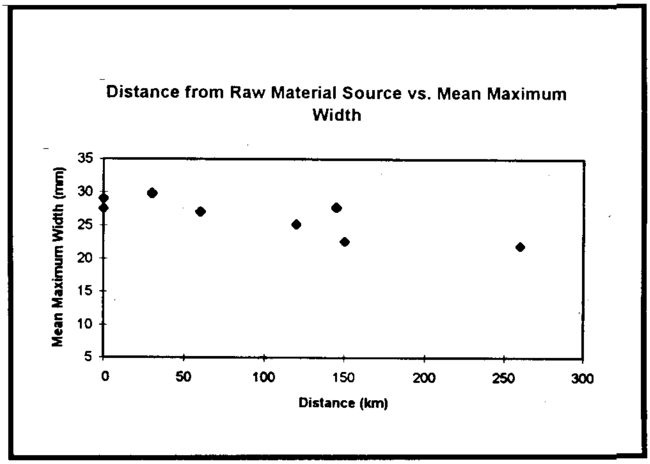

Figure 14. Distance from raw material source vs. maximum width.

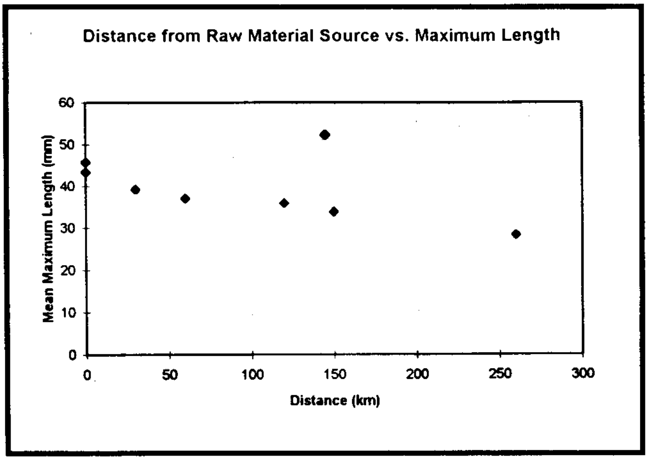

Figure 15. Distance from raw material source vs. maximum length

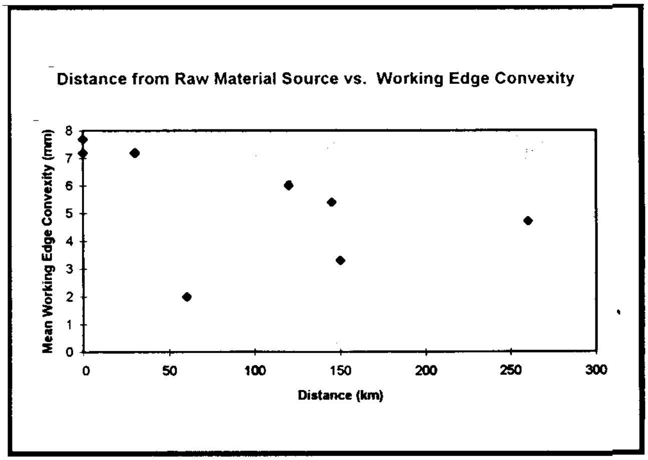

Figure 16. Distance from raw material source vs. working edge convexity.

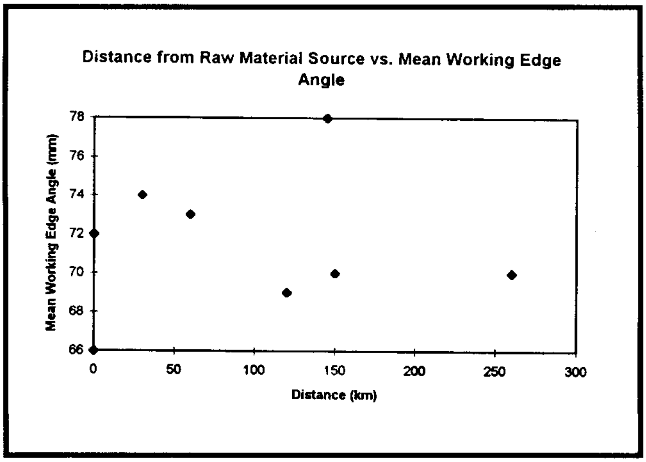

Figure 17. Distance from raw material source vs. mean working edge angle.

thickness is relatively unaffected by resharpening and use, the change in thickness is most likely attributable to changes in flake blank source. Apparently, Paleoindians were using thinner flake blanks for the production of end scrapers with increasing distance from the raw material source. Based on experimental results, the thinner end scraper flake blanks were most likely derived from bifacial cores. The decrease in maximum end scraper thickness lends support to the concept of bifaces as transported cores.

The remaining four attributes recorded for this study, length, width, working edge angle and working edge convexity, may bear a relationship to the use-life and depletion of end scrapers. Examination of these four attributes within the end scraper samples demonstrates changes in end scraper morphology with increasing distance from raw material source areas. Ready Burlington end scrapers are, overall, larger. Maximum width is strongly negatively correlated with distance from lithic raw material source area, and this correlation is statistically significant (Table 7; Figure 14). Maximum length and working edge convexity also tend to decrease with increasing distance from source area, but these attributes are not as strongly correlated as is width (Figures 15 and 16). Overall, with increasing distance from raw material source area, Paleoindians were discarding end scrapers that were shorter and narrower, and had less convex working edges. These changes in the dimensions of end scrapers may have been caused, in part, by increased resharpening and use depletion; however, end scraper size may also be related to initial flake blank size.

If the decreasing size of end scrapers with distance away from raw material source area was solely due to increased maintenance of transported tools, there should also be a corresponding increase in average edge angle. This is, however, not born out by the samples analyzed here. While average edge angle increases slightly with distance, the correlation is far from significant (Table 7; Figure 17). Though end scrapers made of raw materials that were far removed from their respective raw material sources do tend to be smaller, they do not appear to have been more extensively resharpened. In other words, these end scrapers may simply have been somewhat smaller to begin with, perhaps as a result of their having been manufactured from smaller flake blanks. The production of end scrapers on smaller, and especially thinner, flake blanks of raw materials carried greater distances away from their sources is consistent with the use of bifaces as transported cores.

SUMMARY AND CONCLUSIONS

This study of end scrapers from the Bostrom and Ready sites in western Illinois and the Martens site in eastern Missouri has focused on identifying the technological sources of flake blanks used to produce end scrapers and on examining patterns of end scraper manufacture and maintenance with respect to the raw materials represented and their relative distances from these sites. The correlation between distance from raw material source and thickness suggests that different core forms were contributing flake blanks for the manufacture of end scrapers as distance from source increased. The reduction of bifaces appears to have supplied a greater percentage of flake blanks for end scrapers away from lithic raw material source areas than closer to those areas. This pattern lends some support to the idea that bifaces served as transported cores during the Early Paleoindian period. At the same time, the presence of thicker end scrapers bearing simple striking platforms of raw materials up to 260 km from their respective raw material sources indicates that end scrapers (or flake blanks for making them) were also produced at source areas and transported away. A mix of both organizational strategies, "bifaces as transported cores" (cf. Kelly and Todd 1988) and production of flake tools/ flake blanks at raw material sources, may have been employed by Clovis knappers at the Ready, Bostrom, and Martens sites.

ACKNOWLEDGMENTS

This paper is a slightly revised version of one chapter of my dissertation, "The Organization of Early Paleoindian Lithic Technology in the Confluence Region of the Mississippi, Illinois, and Missouri Rivers" (Washington University, 1996). First and foremost, I thank all of my committee members who patiently read and commented on earlier drafts: Drs. David Browman, Gayle Fritz, Fiona Marshall, Jill Pasteris, Hal Levin, and especially, Patty Jo Watson. I am very grateful to Toby Morrow for providing experimental data and end scraper illustrations. I'd like also to thank all of the participants in the original symposium who stuck it out until the end, and Mike Rondeau, in particular, for all of his help. I owe a debt of gratitude to Pete Bostrom (Lithic Casting Lab, Troy, Illinois), Richard Martens (Missouri Archaeological Society), and Jess Ready for permitting me to analyze their collections. I thank Tony Baker, Dr. John Fagan and Dr. George Odell for their comments and suggestions. None of the above persons should be held responsible for any errors within.

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- TABLES -

Table 1. Diagnostic Paleoindian and Early Archaic bifaces from the Bostrom and Ready sites.

Type	Bostrom	Martens	Ready	Median age estimates (yrs B.P.)
Clovis	12	16	26	ca. 11,000 (Haynes et al. 1984)
Gainey	2	-	1	ca. 10,750 (Simons et al. 1984)
Folsom	-	-	1	ca. 10,600 (Frison 1991)
Dalton	-	2	4	ca. 10,000 (Goodyear 1982)
Agate Basin	-	-	2	ca. 10,000 (Frison 1991)
St. Charles	1	-	-	ca. 9,200 (T. Morrow 1996)
Thebes	2	-	1	ca. 9,200 (T. Morrow 1996)
Lost Lake	1	-	-	ca. 9,200 (Justice 1987)
Hardin	1	1	1	ca. 8,700 (Behm 1985)
Bass	-	-	2	ca. 8,700 (Behm 1985)
Kirk/Stillwell	1	1	1	ca. 8,700 (Brown and Vierra 1983)

Table 2. Metric and morphological attributes of the end scraper assemblage from the Twin Ditch site (11GE146)

CAT. NO.	ML	MW	M	WEC	EA	SPM	SPA	ESM
2-21-6 +	63.5	37.1	7.4	5.8	63	5	1	5
8/12/13/23/24	78.0	33.5	9.0					
8/12/06	52.9	25.9	8.2	11.6	76	4	4	1
12-10-4 +	86.0	40.9	9.2	8.0	57	3	4	5
12/12/01	85.3	35.0	14.6	11.6	53			3
12/12/03	46.5	30.0	8.6	8.2	57			2
12/12/06	57.8	28.0	5.0	9.6	53	5	1	3
24-09-12		28.8	7.2	3.5	62			7
24-09-15	53.0	32.3	9.3	9.3	70	4	1	2
25-10-19	40.0	32.0	8.0	9.2	55	2	4	5
25-11-1	102.7	53.6	14.3	11.7	45	3	1	4
34-07-2	59.6	34.2	12.6	8.0	75			6
51-08-2	92.7	38.5	10.5	13.0	57		1	2
66-07-3	74.4	35.3	15.1	5.2	50	1	4	2

Table 3. Summary of attributes of Paleoindian end scrapers from the Bostrom and Ready sites and Early Archaic end scrapers from the Twin Ditch site.

Attribute	**Bostrom Attica (mm)**		**Ready Blair (mm)**		**Bostrom Attica and Ready Blair**		**Twin Ditch (mm)**	
Length (range)	52.0-17.8		51.6-24.7		51.6-17.8		102.7-40.0	
Length (mean)	28.4		35.88		-		68.65	
Width (range)	32.1-16.3		29.7-21.2		32.1-16.3		15.1-5.0	
Width (mean)	22.0		25.18		-		34.65	
Thickness (range)	11.9-3.6		9.2-6.1		11.9-3.6		15.1-5.0	
Thickness (mean)	7.6		7.98		-		9.93	
Edge Angle (range)	95-40		85-56		95-45		76-45	
Edge Angle (mean)	70		68.50		-		59.46	
WEC (range)	8.0-1.0		9.0-3.5		9.0-2.0		13.0-3.5	
WEC (mean)	4.7		6.0		-		8.8	
ESM Category	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
Triangular	17	57	4	67	16	62	1	7
Tapered	9	30	2	33	9	35	4	29
Parallel	1	3	-	-	-	-	3	21
Convergent	1	3	-	-	1	4	1	7
Irregular	2	7	-	-	1	4	3	21
Double Ended	-	-	-	-	-	-	1	
SPM Category	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
Cortical	2	13	-	-	-	-	1	12.5
Simple	5	31	-	-	4	25	1	12.5
Unifacial Ventral	1	6	1	25	1	6	2	25.0
Unifacial Dorsal	3	19	4	75	7	44	2	25.0
Bifacial	5	31	-	-	4	5	2	25.0

Table 4. Replicated Paleoindian end scraper metric changes with successive resharpenings.

SCRAPER	RESHARPENING	ML	MW	MT	WEC	EA	METHOD
1	0	77.7	37.2	10	8.8	57.3	SH
1	1	73.6	37.2	9.3	8.5	58.3	SH
1	2	71	37.1	9.3	8.4	64	SH
1	3	70	37.1	9.2	9.1	65	SH
1	4	68.1	37.1	9.2	7.6	58.7	SH
1	5	66.8	37.1	9.2	9.5	62.3	SH
1	6	64.5	37	9.2	8.4	69	SH
1	7	63	37	9.2	7.7	72.7	SH
1	8	61.1	36.2	9.2	8	68.7	SH
1	9	58.3	35.8	9.2	6.4	71	SH
1	10	55.1	35.1	9.2	4.7	71	SH
1	11	52.6	34.5	9.2	6	69	SH
1	12	50.6	34	9.2	5.1	74	SH
1	13	49.7	33.7	9.2	5.3	69.7	SH
1	14	47.2	33.2	9.2	5.5	68	SH
1	15	44.7	33.1	9.2	6.9	76	SH
1	16	43.2	33	9.2	5.6	72	SH
1	17	42.7	32.7	9.2	6.1	69.3	SH
1	18	40.6	32.7	9.2	6	79.3	SH
1	19	37	32.1	9.2	4.2	74.3	SH
1	20	35.6	30.6	9.2	4	67	SH
1	21	33.8	30.1	9.2	4.3	74	SH
1	22	31.7	29.6	9.2	3.3	70.3	SH
1	23	30.4	28	9.2	4	76.7	SH
1	24	27.5	28	9.2	2	75.7	SH
1	25	26.3	27.6	9	2.1	78	SH
2	0	37.5	29.8	4.4	8.2	54	PRESS
2	1	35.8	29.1	4.4	8	48.7	PRESS
2	2	35.2	29.1	4.4	8.2	48	PRESS
2	3	34.6	29.1	4.4	9	52.3	PRESS
2	4	33.8	29.1	4.4	8.4	50	PRESS
2	5	33.5	29.1	4.4	9	47	PRESS
2	6	33	29.1	4.4	9	50.7	PRESS
2	7	32.1	28.8	4.4	8.6	55	PRESS
2	8	31.6	28.8	4.4	8.5	59.3	PRESS
2	9	30.8	28.7	4.4	7.3	53.3	PRESS
2	10	30.2	28.7	4.4	8	56	PRESS
2	11	29.6	28.7	4.4	6.2	60.3	PRESS
2	12	28.2	28.7	4.4	5.5	67	PRESS
2	13	27	28.3	4.4	5.3	65.7	PRESS
2	14	26.1	28.1	4.4	4.4	63	PRESS
3	0	49.4	26.1	7.9	7.7	67	SH
3	1	46.4	26.1	7.6	6.7	62.3	SH
3	2	45	26.1	7.6	6.3	60.7	SH
3	3	43.5	26.1	7.6	5.3	56.7	SH
3	4	42	26.1	7.6	6.6	64.3	SH
3	5	40	26	7.6	6.2	75	SH
3	6	37.5	26	7.6	4	70	SH
3	7	35.4	26	7.6	3.4	80.3	SH
3	8	32.8	25.5	7.2	4.2	68.7	SH
3	9	30.3	24.2	7.2	3.7	71.7	SH
3	10	27.9	23.7	7.2	1.5	80.3	SH

SH = Soft hammer percussion, PRESS = Pressure flaking.

Table 5. Correlation Coefficients and Associated Probabilities for End Scraper Attributes vs. Resharpenings for Experimental End Scraper 1.

Attribute	Correlation Coefficient (r)	Probability
Mean Length	-0.999	< 0.001
Mean Width	-0.968	< 0.001
Mean Thickness	-0.468	> 0.01
Mean WEC	-0.912	< 0.001
Mean Edge Angle	+0.784	< 0.001

Table 6. Summary metric and morphological attributes of end scrapers from the Ready, Bostrom, and Martens sites.

Site[1]	RM[2]	D	N1	xML	xMW	xMT	xEA	xWEC	N2	%Tri	%Tap	%Para	%Conv	%Irreg
R	Bu	0	62	43.3	29.0	9.1	66	7.7	61	81	18	-	-	2
R	Bl	120	6	35.9	25.2	8.0	69	6.0	6	67	33	-	-	-
B	Bu	60	39	37	27	8.8	73	2.0	31	29	58	-	-	13
B	A	260	36	28.4	22	7.6	70	4.7	30	57	33	-	5	5
B	C	145	12	52.3	27.7	8.7	78	5.4	12	33	42	17	-	8
B	K	150	9	33.8	22.6	6.8	70	3.3	8	67	-	-	33	-
B	S/S	30	36	39.2	29.8	9.0	74	7.2	31	39	48	3	-	10
M	Bu	0	11	45.7	27.5	9.4	72	7.2	11	73	27	-	-	-

Site[1]	RM[2]	N3	SP1	SP2	SP3	SP4	SP5	%SP1	%SP2	%SP3	%SP4	%SP5	%1&2	%3&4	%5
R	Bu	37	14	5	7	7	4	38	13	19	19	11	51	38	11
R	Bl	4	-	-	1	3	-	-	-	25	75	-	-	100	-
B	Bu	15	1	8	3	-	3	6	56	19	-	19	62	19	19
B	A	16	2	5	1	3	5	.13	31	6	19	31	44	25	31
B	C	3	-	-	1	2	-	-	-	33	64	-	-	100	-
B	K	1	-	-	1	-	-	-	-	100	-	-	-	100	-
B	S/S	17	3	5	-	5	4	18	29	-	29	24	47	29	24
M	Bu	5	0	1	1	0	3	-	20	20	-	60	20	20	60

[1] B = Bostrom, M = Martens, R = Ready.

[2] A = Attica, Bl = Blair, Bu = Burlington, C = Cobden, K = Kaolin, S/S = Salem/St. Louis

Table 7. Lithic raw material source distance vs. recorded metric and morphologic end scraper attributes.

Raw Material Source Distance vs.	r	n	Probability
Length	-0.5164920	8	>.1
Width	-0.8308250	8	<.01
Thickness	-0.7713356	8	<.05
Edge Angle	+0.0841565	8	>.1
Working Edge Convexity	-0.4735237	8	>.1
% Cortical Striking Platforms	-0.4707841	5	>.1
% Bifacial Striking Platforms	-0.0280349	5	>.1

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