## CONTENTS

**Evolutionary Perspectives on Bipolar Technology**  
JUSTIN PARGETER AND HILARY DUKE  

**A rticles**

**A Qualitative Guide to Recognize Bipolar Knapping for Flint and Quartz**  
PALOMA DE LA PEÑA  

**“Dissecting” Quartzite and Basalt Bipolar Flake Shape: A Morphometric Comparison of Experimental Replications from Olduvai Gorge, Tanzania**  
ALIA N. GURTOV, BRIGGS BUCHANAN, AND METIN I. EREN  

**Dynamics of Knapping with Bipolar Techniques: Modeling Transitions and the Implications of Variability**  
PETER HISCOCK  

**Weaving Simple Solutions to Complex Problems: an Experimental Study of Skill in Bipolar Cobble-splitting**  
HILARY DUKE AND JUSTIN PARGETER  

**Microwear Analysis of Bipolar Tools from the Crescent Bay Hunt Club Site (47JE994)**  
ROBERT J. JESKE AND KATHERINE M. STERNER-MILLER  

**Diversity Under the Bipolar Umbrella**  
MICHAEL SHOTT AND GILBERT TOSTEVIN
MICROWEAR ANALYSIS OF BIPOLAR TOOLS FROM THE CRESCENT BAY HUNT CLUB SITE (47JE904)

ROBERT J. JESKE AND KATHERINE M. STERNER-MILLER
Department of Anthropology, University of Wisconsin-Milwaukee, 3413 N. Downer Ave, Milwaukee, WI 53211, USA

Previous microwear analysis of a sample of artifacts from the Crescent Bay Hunt Club site has demonstrated that, in general, morphofunctional typology has limited value for the assessment of tool function at that site. The site is a small Oneota village (AD 1200–1400) near Lake Koshkonong in southeastern Wisconsin. Multiple data sets indicate a year round occupation, a subsistence regimen of maize agriculture and exploitation of a wide variety of plants, large and small mammals, birds, reptiles, fish, and shellfish. Mortuary data indicate significant levels of interpersonal violence. This analysis is an attempt to determine if lithic manufacturing techniques are correlated with tool use at the site. The analysis incorporates low power and high power microscopy of morphofunctionally defined bipolar cores and/or pièces esquillées, as well as triangular arrow points. These tools were made using both bipolar and free hand knapping techniques; the analysis was designed to determine if a bipolar manufacturing origin is related to specific functions. Results indicate that both the bipolar cores and triangular points were used on a variety of materials, including hide, plant matter, and wood. From this we infer that a bipolar manufacturing origin is not predictive of subsequent tool use at the site.

KEYWORDS: Oneota, Bipolar technology, Lithics, Microwear analysis

The relationship between form and function of stone tools has long been an important matter to archaeologists. Multiple approaches have been used to determine individual tool use, including macroscopic, microscopic, and chemical methods of analysis. Each approach has strengths and weaknesses. A multi-pronged approach is likely necessary to contextualize tool function within any specific lithic technological system. This context includes the understanding of tool production as it relates to the physical use of a tool. In this regard tool production is integrated into multiple aspects of culture, including social, ideological, and biological requirements. Unlike a chaîne opératoire model of technology, tool production and tool use are not seen as steps in a chain of actions but are connected to each other, and to all other aspects of lithic technology, in a web of relations that bind together resources, needs, producers, and consumers (cf. Dobres 2000; Jeske 2003; Shott 2003; Tostevin 2006). Exploring tool reduction techniques and their relationship to tool use is one way to recognize that methods of tool production will vary based.
on a multitude of circumstances. It is the inherent immediacy of the relationship among the variables that results in the life cycle of any tool. Raw material acquisition can only be seen in light of expected tool function, relative accessibility of multiple raw materials, and the economic, political, social and ideological constraints on energy expenditures for making tools at any time or place within any particular culture. Likewise, production methods, use, reuse, recycling, and deposition of tools depend on the interplay of these same factors, as well as the choice of raw material.

In this paper we examine how a particular chipped stone tool technique, the bipolar technique, relates to other aspects of lithic technology. Specifically we examine bipolar tools from the Crescent Bay Hunt Club site, a C. AD 1200–1400 Oneota village near Lake Koshkonong in southeastern Wisconsin. Both low power and high power microscopy are used on 15 morphological variants of bipolar cores and/or pièces esquillées to determine if a bipolar manufacturing origin is correlated with tool function at the site. We also examine triangular tools (aka Madison Points [Justice 2005]), many of which are produced using a bipolar technique and finished with varying amounts of free hand percussion and pressure flaking, to determine if their assumed functional designation as arrow point is warranted.

PROJECT BACKGROUND

For much of the middle to late 20th century, the existence, let alone meaning, of bipolar lithic technology was a contentious issue among North American archaeologists (Barham 1987; Binford and Quimby 1963; Hardaker 1979; Hayden 1980; Honea 1965; Kobayashi 1975; Leaf 1979; Patterson 1979; Shott 1989, 1998, 1999; Sollberger and Patterson 1976). Bipolar is distinguished from other block-on-anvil techniques in that the objective piece (i.e., core) is held on top of a stone anvil and struck with a hammer at or very near a 90° angle; a blow perpendicular to the anvil. The contact sends force into the core from one opposing point: from the point of hammer impact and from the point of impact with the anvil. Other reduction techniques using anvils exist: for example, the passive anvil technique used by Bordes to replicate *levallois* cores and flakes (Bordes 1980). Bordes demonstrated that relatively large blocks of high quality stone could be swung onto an anvil to remove flakes in a well-controlled fashion, replicating *levallois* cores and tools found in many Moustérien assemblages. Our current research, the use of bipolar technology in the late prehistoric of the U.S. western Great Lakes region, varies significantly from Bordes’ replication experiments.

Binford and Quimby’s (1963) seminal article set the stage for a vigorous exchange of views about bipolar technology in the Great Lakes region: if it was ever used, if it was used only in a restricted area or time, if it was used only under extreme circumstances, or if it was used to produce particular artifact forms designed to function as specialized tools. Explanations for bipolar techniques were many: lack of skill (Patterson 1979), lack of good quality raw material (Binford and Quimby 1963), small cobble size (Flenniken 1981; Salzer 1969), and reuse of bifaces by highly mobile groups (Goodyear 1993) were common themes in the literature. It seemed that the “confusion in the bipolar world” (Hayden 1980) was that bipolar technology “was a multidimensional problem that varied greatly due to local geologic, geographic, and demographic situations” (Jeske and Lurie 1993:134).

In an attempt to unravel one part of this multidimensional problem, Jeske and Lurie conducted a set of experiments designed to investigate if archaeologists could ascertain with certainty if prehistoric knappers used bipolar technology to produce any particular lithic assemblage (Jeske and Lurie 1993; Joslin-Jeske and Lurie 1983). They focused not on tools, but on the flakes and debris from knapping cores. The blind-study experimental evidence demonstrated that bipolar technology as a reduction sequence left a clear signature in debitage assemblages. The data also showed that recognizing any single piece of lithic debris as bipolar was not possible statistically. It was the patterning of the assemblages that made prediction possible. Both bipolar and free hand hammer techniques produced the same types of flakes and debris, but in different proportions.

Jeske and Lurie only examined debris, not tools. The problem of bipolar tool function remained. The tool type “wedge” had been identified at several Middle Archaic sites in the Lower Illinois River Valley (e.g., Cook 1976; Stafford 1989), but beyond morphofunctional description, these tools were not considered in any detail. On the other hand, in the forests of Wisconsin and Michigan, these so-called wedges were common and considered by many to be wood or bone working tools. In the far north, wedges were
commonly made of quartz or other less than desirable material for chipping into shape. Wedges were separated from bipolar cores as early as 1967 (McPherron 1967). In addition, ground stone artifacts dubbed “ anvils” were also found in these northern sites (Salzer 1969:300), while other ground stone artifacts with cupped depressions were often referred to as “ nutting stones” (Egan 1988; Talalay et al. 1984:351). Paradoxically, the notion that the production and function of bipolar tools were readily identifiable was well established among non-lithic specialists at the same time it was contentious within the flintknapping community.

Two particular morphofunctionally defined artifact forms found in Late Prehistoric periods of the Upper Midwest and Great Lakes, the Madison Triangular projectile point and the so-called Humpback knife or scraper (Brown 1961; Munson and Munson 1972), were a definite problem for understanding tool use among Langford and Oneota sites in northern Illinois (Jeske 1992). There was general consensus that thin triangular bifaces were arrow points (Madison Points), but the function of the thicker triangular bifaces with humped dorsal surfaces was contested. Archaeologists invoked multiple functions based on tool morphology such as “ point” (Bluhm and Liss 1961), “ unfinished point” (Fowler 1952), “ knife” (Brown 1961), and “ scraper” (Munson and Munson 1972). Using a combination of assemblage composition, low-power microscopic data, and a much smaller high-power microwear data set (Hohol 1985), Jeske argued that Madison Points and Humpbacks were neither one tool type nor another, but were better thought of as a continuously variable morphology resulting from minimal retouching of flakes produced using a bipolar technique. Morphological variation in the tool was the result of variation in flake blank thickness inherent in bipolar reduction, and was not the result of functional considerations. What analysts called Madison Triangular projectile points were actually thinner versions of the Humpbacked Knife or Scraper and there was little to no evidence for functional differentiation. Yet, the lack of systematically recovered functional data made it impossible for Jeske to discuss any particular function for these tools at all, aside from some contextual evidence in skeletal elements that triangular tools did function as arrow or dart tips in some cases (e.g., Langford 1927).

New and improved methods for recognizing the function of tools have provided a new warrant for the reexamination of bipolar tools from the Great Lakes region. We suggest that tools that were produced using a bipolar technique were probably used in a wide range of activities, including woodworking, hide scraping, cutting, and flake production. In this case we have a large sample of well provenieneced tools that we can examine using both low power and high power microscopy. In addition blood residue analysis has also provided another line of evidence to suggest tool function on a few of these tools.

SITE BACKGROUND

The Crescent Bay Hunt Club is located on a ridge above a large lake in southeastern Wisconsin, approximately 90 km west of Lake Michigan (Figure 1). The regional environment is rich and varied, but outcrops of usable chert are rare. Initially identified by avocational archaeologists at the turn of the 20th century (Stout and Skavlem 1908), the site was the focus of limited excavations by David Baerreis of UW Madison in 1968. The work was documented with limited field notes, an unpublished analysis of ceramic and lithic artifacts (Gibbon 1969), and at least one master’s thesis (Fortier 1972). Excavated by UW Milwaukee over the course of nine field seasons since 1998, Crescent Bay has yielded hundreds of storage and processing features, hearths, burials, and evidence for both wigwam and longhouse style houses (Edwards IV 2010; Foley Winkler 2011; Jeske et al. 2003; Moss 2010). More than 20 radiocarbon dates place the main occupation during the 13th and 14th centuries (Jeske 2001), with a small but intriguing number of food residue dates suggest that occupation may have occurred as early as the late 11th century. Approximately 400 ceramic vessels, all but one of which fits the definition of Oneota, have been recovered (Schneider 2012; 2015). Faunal and floral data indicate year round habitation of the site, with a meat diet that included a wide variety of large and small mammals, including bison, elk, white-tail deer, raccoon, and squirrel. Other animals utilized include turtles, fish, mollusks, and waterfowl (Edwards 2010; Hunter 2002). Plant use included cultivated maize, and the collection and/or cultivation of wild rice, goosefoot, sunflowers, and a wide variety of wild seeds, nuts, and fruits (Olsen 2003). The very broad subsistence regime incorporated upland grassland,
deciduous forest, wetland, savanna, riverine, wetlands, and open lake environments. The utilization of these highly varied environments and broad species utilization suggests a toolkit that had to be flexible and generalized, with some highly specialized procurement and processing tools.

The chipped stone assemblage is typical of late prehistoric sites in the region: relatively small tools produced on locally available cobbles of chert. Formal tool types are almost entirely triangular pieces — sometimes bifacial, sometimes simply edge-retouched pieces — and steeply edged unifaces, along with wedge-shaped or columnar multifacial pieces usually called bipolar cores, wedges, or pièces esquillées. Informal edge-retouched pieces make up the bulk of the remainder of the assemblages. The site has a very low debitage to tool ratio of only 9:1, based on 6.3 mm screen recovery (Sterner 2012). The chipped stone assemblage is complemented by a wide variety of groundstone, bone, shell, and copper tools.

METHODS

For this study, we focused on only two morpho-functionally defined forms: triangular points and
bipolar cores/pieces esquilléées. To examine the tools we used both high power and low power use-wear analysis in order to extrapolate the greatest amount of functional information from the tools. This combination of techniques is the most common approach in recent analyses (Beyin 2010; Brass 1998; Clemente and Gibaja 1998; Jeske 2002). Two microscopes were utilized for this project: the Amscope SE305-AZ-P binocular stereoscopic microscope was used for low power analysis and the Olympus BH-2 upright microscope with reflected light fluorescence attachment was used for high power analysis.

Tools were prepared for analysis by washing them in an ultrasonic bath of warm water with dish detergent for 30 minutes. Artifacts were examined at 10× and 30× magnification to identify traces of wear such as rounding and microchipping. Differential rounding or microchipping on the dorsal or ventral side of an edge is typically interpreted to signify that the tool was used in a transverse motion such as scraping. Equal amounts of rounding and microchipping on both the dorsal and ventral sides of the functional edge are usually a sign that the tool was used in a longitudinal motion such as cutting (Kamminga 1982; Odell 1981, 2004).

The tools were then examined at 200× and 500× magnification in order to identify micropolishes. Photomicrographs were taken of polish on the archaeological tools and compared to our reference collection of experimental tool polishes. The comparative tools were used for activities including bone scraping, limb disarticulation, hide removal, wet and dry hide scraping, meat cutting, wood whittling on both hard and soft wood, and slicing of vegetal matter such as potatoes and grass. Comparative tools used for this analysis were utilized for a minimum of 15 minutes in order to allow sufficient polish to develop. Polishes were identified based on the brightness of polish, surface area covered, linkage and pitting (Bamforth 1988, 2010; Evans and Donahue 2008; Rots and Williamson 2004; Vaughan 1985). Diagnostic worked material polishes which have been identified in previous analyses of archaeological stone tools from the Crescent Bay Hunt Club site include bone polish, antler polish, wet and dry hide polish, meat polish, plant polish, and reed polish (Sterner 2012). In many cases, a diagnostic polish may not be identifiable due to a number of variables including a lack pressure placed on the tool, short time of use, or post-depositional processes. In the case of the two former circumstances, intermediate “smooth pitted” polish or “generic weak” polish may be apparent, which provides evidence that the tool was used, although a specific worked substance may not be identifiable (Vaughan 1985:320). “Grit” polishes may also develop on tools as part of the production process or as a result of post-depositional processes (Vaughan 1985:38). Resharpening of the tool may result in the removal of use evidence from the edge of the tool, although in some cases only partial removal or the polished edges and/or surfaces may occur.

In the current study, 50 per cent of examined triangular tools displayed polish diagnostic of a specific worked material (Figure 2) and 30 per cent of multifacial pieces showed recognizable polish. Additional information about the function of three triangular tools was derived from a previous cross-over immunoelectrophoresis (CIIP) blood residue analysis of the tools which identified one dog residue, one bison, and one probable deer (Sterner et al. 2013).

**Triangular Tools**

A total of 13 triangular tools were examined for this analysis (Figure 3). All but one of them showed some evidence of use; nine demonstrated polish while the other three showed microflaking, rounding and/or striations along an edge.

**NO WEAR**

Tool 221 is a triangular tool that was split on an anvil. No wear was seen on the edges, but some grit polish is evident. No function can be assigned. Tool 189 is a crude triangular tool that has been broken longitudinally. No wear is recognizable on the new edge. The microflaking present on the lateral margins of the tool appears to be from production, not use.

**STRIATIONS**

Tool 278 yields striations perpendicular to the lateral margin of the tool, but no definitive wear. The striations and equal rounding on both the dorsal and ventral sides of the tool provide conflicting interpretations of motion it was used in. Typically striations are the best indicator of motion and suggest that this tool was used in a transverse motion, but on what material we cannot say.
WOOD POLISH

Tools 123 and 54 show wood polish on the proximal edge. Tool 54 also shows wood polish on its dorsal hump. We interpret these patterns as likely due to hafting wear. Tool 194 showed a small amount of moderately developed polish on the lateral portions of the distal edges. Combined with microflaking and some rounding, this pattern suggests incidental contact with wood, perhaps in the context of slicing meat or other soft material. A similar interpretation of several tools was reported in early experiments by Cahen et al. (1979).

PLANT POLISH

Tool 106 shows no edge work at all, but plant polish on the hump. This polish may have resulted from contact with cordage used in hafting. We have not yet replicated this exact scenario experimentally, so our interpretation remains speculative.

HIDE POLISH

Fully 50 per cent of 13 triangular tools show evidence of hide polish. Of these, tools 107, 536, and 226 show hide polish on their proximal portions and/or humps, indicating hafting wear. Tool 226 is a very crude triangular that was subsequently split longitudinally on an anvil after being unhafted. Tool 536 is especially interesting in that it was heavily retouched on all three edges with flake scars ending at the hump, and then was apparently discarded. The traces of hide wear remain on the front portion of the hump itself.

Two triangular tools have fresh hide polish on their lateral distal portions, and also show the differential rounding and microflaking patterns that indicate scraping. Blood residue analysis indicates tool 429 was used on bison and tool 390 was used on deer.

MULTIFACIAL PIECES

A total of 15 multifacial pieces were examined using microscopy (Figure 4). Of these, eight (53 per cent) demonstrated evidence of use.

NO WEAR

Six (or 40 per cent) multifacial pieces show production microflaking, battering, and edge chattering characteristic of bipolar production, but no other use wear or polish. Five of these are the lozenge or pillow shaped forms contradictorily referred to as either bipolar cores or pièces esquillées in the literature (tool numbers PE1, PE3, PE5, PE6, and PE7). One is a columnar piece (tool number 285). All of these fit the category of bipolar debitage or cores.
WOOD POLISH

Four multifaces (27 per cent) yielded evidence for wood polish (tool numbers 113, 122, 328, and 377). Two of these tools are lozenge shaped. One shows wear on its lateral margins and the other has polish only on the hump. Tool 328 is a columnar piece with wear on its lateral margin. The combination of flake damage and polish data suggests strongly that these tools functioned as wedges or slotting tools.

Tool 377 is a great example of creative reuse. A bifacial tool with a broken tip was split using a bipolar strike across its body, forming it into a multifacial piece. The 90° angled edge formed by the new break and one original face was then used in a scraping motion across wood.

PLANT POLISH

Tool 172 is a lozenge shaped piece that shows plant polish along the distal edge, suggesting use in scraping fibrous materials such as the inner portion of bark or other plants.

DRY HIDE

Somewhat surprisingly, three multifaces (20 per cent) show dry hide polish. Tool 190 is a lozenge that shows polish on its lateral margin. PE₄ is a columnar piece with polish on its lateral margin, while PE₂ is a columnar piece that yields hide polish along a dorsal ridge and adjacent surfaces.
SUMMARY AND CONCLUSIONS

We take several conclusions from these results. The first is that the use of a bipolar technology to produce or rework tools is not predictive of subsequent tool function. The edge damage and polishes exhibited on our sample of the Crescent Bay Hunt Club bipolar tools indicates a wide range of materials and motions — some expected, and others puzzling. Scraping, chopping, and slicing motions are evident. Fresh hide, dry hide, plant, and wood are all clearly apparent on this very small sample of tools. It is highly likely that an even wider array of materialpolishes will be detected as we increase our sample size.

Second, once again, it is clear that tool form does not necessarily follow function, or vice versa. At least for late prehistoric Native American produced assemblages in the southern Great Lakes region, using a morphofunctional typology as an explanatory framework for tool or site function has little utility at best. At worst, it
will most probably be misleading. Nonetheless it is still common for archaeologists to continue to cling to the idea that form and function are systematically related — to the detriment of our understanding of lithic technology. Certainly the continued use of terms such as knife to describe asymmetric bifaces or point for bifaces with apparent hafting elements (e.g., thinned distal edges, stems, or notches) demonstrates an unreflective approach to recognizing variation in chipped stone assemblages.

Finally, we must also recognize that chipped stone tools, often given privileged status in analyses because of their ubiquity, were often used in conjunction with groundstone, bone, wood, and metal tools. The tasks indicated by a functional analysis of only the chipped stone tool assemblage from a site do not necessarily equate to the significance of those tasks in the dynamic culture that produced the tools. The variety of activities indicated in this analysis will be greatly enhanced once equivalent analyses are completed for the tool assemblages made from non-siliceous materials. Only a multi-pronged approach to assessing tool assemblages — macroscopic analyses of debitage and tools to determine choices in raw material acquisition and modification, tool reuse and discard rates, microwear identification of tool motion and materials processed, as well as chemical techniques such as blood residue, starch grain, and phytolith analyses to obtain species level identification of materials processed — can provide any basis for a realistic understanding of the role of stone tools in the economy of everyday life.

ACKNOWLEDGMENTS

We thank Jean Hudson and the UWM Experimental Archaeology Working Group for providing a nurturing environment for experimental use wear studies. We thank John Fagan and Cam Walker (Archaeological Investigations Northwest, Inc.), for their work on the blood residue analysis. Many thanks to Justin Pargeter and Hilary Duke for organizing the Society for American Archaeology session and this volume. Finally we very much appreciate Gilbert Tostevin and Michael Shott for their comments, as well as the comments from two anonymous reviewers for Lithic Technology.

REFERENCES


Sterner, Katherine M., Robert J. Jeske and Sara A. Shuler 2013 Results of Blood Residue Analysis and Microwear of Suspected Arrow Points and Scraping tools from the Crescent Bay Hunt Club Site (47J904). Paper Presented at the 59th Annual Meeting of the Midwest Archaeological Conference, Columbus, Ohio.

**Notes on Contributors**

Robert J. Jeske is a Professor of Anthropology, and directs the Archaeological Research Laboratory, at the University of Wisconsin Milwaukee. He is also an Adjunct Curator of Anthropology at the Milwaukee Public Museum. His research is largely concentrated on lithic analysis, mortuary analysis, site formation processes and the prehistory of the western Great Lakes region of North America.

Correspondence to: Robert J. Jeske, Department of Anthropology, University of Wisconsin-Milwaukee, WI 53201, USA. Email: jeske@uwm.edu.

Katherine Sterner-Miller is a doctoral candidate in the Anthropology Department at the University of Wisconsin-Milwaukee. She has done fieldwork in England, Mexico, and the Midwestern United States. Her current research interests are microwear and blood residue analysis, Oneota studies, Great Lakes archaeology, and experimental archaeology.