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ARTICLE

A Folsom Foreshaft from the Blackwater Draw Site

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Abstract

This article describes a bison rib bone foreshaft from the Blackwater Draw site, New Mexico. The object was recovered by James Hester in 1963, during the excavation of locality 4, and it was subsequently cataloged as a modified bone tool but not recognized as a hafting element. It is currently held in the Blackwater Draw Museum collections. This analysis provides a detailed description of the artifact's features and establishes its provenience from a Folsom context. A survey of known Paleoindigenous hafting implements and a discussion of theoretical Folsom foreshaft designs serve to reinforce the classification of the tool as a component of the Folsom weapon delivery system. The tool was likely broken during use and later recycled as a pressure flaker or as a polishing instrument. With the help of 3D imagery, a reconstructed model was printed and fitted with large and small Folsom points to test ideas borrowed from the theoretical literature on Folsom foreshaft design.

Resumen

Este artículo describe un intermediario de astil ("foreshaft") de costilla de bisonte del sitio Blackwater Draw, NM. El objeto fue recuperado por J. Hester en 1963, durante la excavación de la localidad 4, y posteriormente catalogado como una herramienta de hueso modificada, pero no reconocido como elemento de enastado ("hafting"). Actualmente se encuentra en las colecciones del Blackwater Draw Museum. Este análisis proporciona una descripción detallada de las características del artefacto y establece su procedencia de un contexto Folsom. Un estudio de los implementos de enastado paleoindígenas conocidos y una discusión de los diseños teóricos de los intermediarios de astil Folsom sirven para reforzar la clasificación de la herramienta como un componente del sistema de lanzamiento de armas Folsom. Es probable que la herramienta se rompiera durante el uso y luego se reciclara como herramienta para descascarar a presión o como instrumento de pulido. Con la ayuda de imágenes 3D, se imprimió un modelo reconstruido y se le equipó con puntas Folsom grandes y pequeñas para probar ideas tomadas de la literatura teórica sobre el diseño de intermediarios Folsom.

Keywords: Folsom; Blackwater Draw; technology; weaponry

Palabras clave: Folsom; Blackwater Draw; tecnología; armamento

The following is an attempt to redirect the attention of lithic technologists toward the perishable components of prehistoric tools such as handles and foreshafts. These elements were intrinsic to the tools' design, and they consequently determined—or at least impacted—how they were used, transported, or when and where they were discarded. Despite this, stone tools are often analyzed without consideration of how they may have been hafted.

The interconnectivity between lithic tools and these ancillary components is well documented in the ethnographic literature. Weedman's (2018) analysis of contemporary Ethiopian (Gamo) hide workers, for instance, has revealed the complexity of symbolisms associated with stone tools, whose life histories are closely interwoven with the belief systems of their users. Not only do the Gamo perceive their tools as living beings, but this rich indigenous ontology also extends to the handles in which the hide scrapers are inserted. Accordingly, the Gamo's various haft styles can help retrace social and even geopolitical structures (Weedman 2006).

In the same vein, field observations have also shown that the lithic element may not always be the central or even the most significant part of the tool. Ethnographic studies of large, polished stone axes from Papua New Guinea, for example, have demonstrated that the fitting of the blade into a wooden handle was the most difficult aspect of the implement's manufacturing process (Burton 1984:124)—so much so that the skills involved were mastered by only a small number of men (see also Pétrequin and Pétrequin 2000).

This arguably small and selective sample of ethnographic cases pales in regard to the now lost technical knowledge related to stone tool production and use that humanity acquired over several million years. It is, nevertheless, sufficient to indicate that archaeologists would benefit from moving away from a Ptolemaic point of view (i.e., one that places stone tools at the center of technological analyses). As a substitute, we argue here for an approach that recognizes the role of other technological components, emphasizes the connections between the systems parts, and relates them to the social and adaptive decisions at their roots.

This argument is not new, given that others have advocated for a more balanced approach to technological systems and emphasized the significance of tool design choices. Wendell Oswalt (1973, 1976, 1987) evaluated the complexity of hunter-gatherer technology based on the number of parts making up their subsistence-related implements, and later, Torrence (1983) elaborated on this. She introduced time and energy as measures of technological organization (see Torrence 1989). Similarly, tool design and complexity have been linked to risk management strategies (e.g., Bamforth and Bleed 1997; Bleed 1986; Hoffecker and Hoffecker 2018).

Although our goal is not to revisit these claims, we see value in these approaches, and for this reason, we would like to emphasize a holistic view of hunting implements—one in which lithic tools can be contextualized and coupled with other aspects of their design. For this, we chose to discuss the hafting of Folsom points in relation to a newly discovered foreshaft in the collections of the Blackwater Draw site in New Mexico.

The recent identification of a bone tool as a weapon component was the result of a reflection process on the hafting of Folsom points. We set out to browse extant collections of bone and antler objects from various Folsom sites in order to identify elements of the weapon delivery system. Because no wooden object had been recovered from any Folsom context, we specifically looked at other materials—namely, bone and antler—for evidence of modification (such as tangs, slits, and perforation) that would point to a potential use as a foreshaft and thereby shed light on the hafting technology.

Several large Folsom collections—such as the ones from Lindenmeier, Agate Basin, or Blackwater Draw—contain a variety of modified bone and antler pieces, including items that have been identified as projectile points (Frison and Stanford 1982; Hester 1972; Wilmsen and Roberts 1978), indicating that these materials were regularly used by Folsom hunters in their daily quest for food. Yet these objects are usually overlooked by scholars in favor of a narrow focus on stone tools and projectile points. Indeed, although there have been numerous studies of how Folsom points were made, hafted, and used, other aspects of the weapon systems—such as foreshafts or bone points—have been largely ignored. This blatant bias has been noted by Bamforth (2009:145), who justly remarked, "It is difficult to think of another domain of archaeological research that relies so overwhelmingly on such a narrow range of data to illuminate ancient lives that were surely as rich and varied as those that were lived by the early occupants of the central North American grasslands."

In search of a more balanced reconstruction of Folsom adaptations and in order to explore the overlooked information, we theorized that unless all weapon delivery system parts were made exclusively of wood (an unlikely situation, given that antler and bone would have been readily available, comparatively easy to work, and more durable), there is a strong probability that Folsom hafts or foreshafts have already been recovered but not necessarily recognized. After all, two of the largest Folsom collections—Lindenmeier and Blackwater Draw—had been acquired quite early in the history of North American archaeology, at a time when our understanding of early prehistory was lacking

Figure 1. Two views of the Blackwater Draw foreshaft. Note that "10" is the original field number assigned by Hester. (Color online)

(Lindenmeier) and was in general vastly incomplete (Blackwater Draw). Consequently, a survey of collections and published materials led to our identification of a modified rib bone from the Blackwater Draw site as a slotted foreshaft (Figure 1). The object's characteristics and archaeological context are discussed below.

Background

Archaeological investigation at the Blackwater Draw site started in the early 1930s under the supervision of E. B. Howard, with funding from the University of Pennsylvania Museum and the Academy of Natural Sciences in Philadelphia (Boldurian 2008). Howard's contribution was followed by sporadic efforts by many others (Boldurian 2007; Boldurian and Cotter 1999; Boldurian et al. 1990; Hester 1972). Because the site was initially operated as a commercial gravel quarry by the New Mexico Highway Department, most archaeological excavations were conducted as ad hoc salvage operations. Unfortunately, this situation resulted in disjointed and often unrelated sets of scientific data collected from multiple localities within the site by distinct research institutions.

The Blackwater Draw locality had been known to local collectors prior to the opening of mining operations, and artifacts found in the area as early as 1929 had been sent to the Smithsonian Institution (Boldurian and Cotter 1999). However, it is E. B. Howard who brought the site to the forefront by featuring it in his dissertation in 1935 and by disseminating information to the research community via publication and outreach (Boldurian et al. 1990). Despite Howard's initial attempts to attract professional interest, a significant amount of all the bone and stone materials recovered from the site initially was procured via the cumulative efforts of local amateurs in areas of wind erosion and in spoil piles produced by gravel mining. Ultimately, it was a more systematic archaeological exploration that bolstered the scientific significance of the site. In 1936, the University of Pennsylvania Museum expedition, under the supervision of Howard and led by Cotter, revealed mammoth remains in situ with 28 artifacts, thereby demonstrating conclusively the contemporaneity of humans with Pleistocene fauna and cementing the locality as the type site for the Clovis complex (Boldurian and Cotter 1999).

In subsequent years, multiple academic institutions became involved in the research conducted at Blackwater Draw. In addition to the University of Pennsylvania Museum, the California Institute of Technology, the Texas Memorial Museum, the University of Chicago, the Museum of New Mexico, Texas Tech University, the Smithsonian Institution, Eastern New Mexico University, and the El

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Llano Archaeological Society excavated in search of traces of Paleoindigenous lifeways (Hester 1972). These uncoordinated efforts varied tremendously in the quality of records produced, and they unfortunately generated more of a patchwork of disconnected data rather than one coherent set of information. The 1962 excavation that produced the Folsom foreshaft is one of many such excavations.

History of Discovery

In 1962, James Hester and James M. Warnica investigated a cutbank where a bison skull had been discovered by avocational archaeologists, adjacent to a flat area that had been stripped down by excavation machines to an artifact-bearing deposit. Two excavations were laid down in areas now known as locality 4 and locality 5. Locality 5 was in the stripped area, and locality 4 was in the cutbank. Locality 4 is where the foreshaft was discovered. There, Hester opened an area approximately 6 m (20 ft.) in length and 3 m (10 ft.) in width, which he then excavated in levels (Hester 1972).

The dig yielded a total of 194 artifacts, including 13 projectile points. The lot comprised both Folsom (seven) and Clovis (one) diagnostics as well as one Plainview and one Agate Basin point. Three other points were unidentified. Hester noted that the Folsom level(s) extended over considerable vertical distance in a brown sand unit (Haynes and Agogino 1966). He subsequently surmised that the bones and artifacts had been redeposited in the 1.8 m (6 ft.) thick brown sand at the edge of the former Pleistocene pond. This conclusion was based on the vertical position of bones and artifacts and the presence of caliche nodules. Moreover, given that some of the caliche nodules weighed several pounds, Hester argued that the site was formed by the destructive activity of major floods, removing remnants of ancient campsites presumably located on the caliche hardpan to the west of locality 4.

Blackwater Draw has undergone significant transformations since the 1960s, and, unfortunately, no field notes for that specific project exist in the museum collections. Consequently, all contextual information from the excavation needs to be extrapolated from Hester's (1972) summary.

Figure 2 shows the north–south profile of locality 4, adapted from Hester's Figure 66 (Hester 1972:64). Note that, except for a mammoth humerus and a horse metapodial recovered in bed 2—a gray sand unit—all bones are *Bison* sp. ($n = 11$). The location of diagnostic projectile points in the profile and of the foreshaft discussed in this essay were inferred based on Hester's plotted artifact

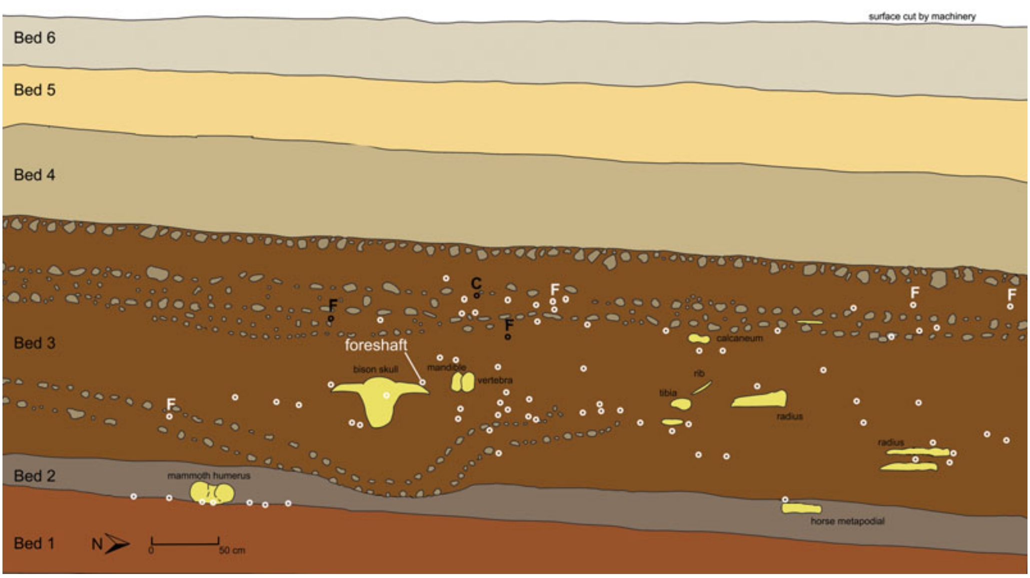

Figure 2. Profile of Hester's excavations at locality 4 showing the location of the foreshaft. The points recovered by Collins are indicated in black, and the ones found by Hester are in white. C: Clovis point; F: Folsom point. Redrawn after Hester (1972), Figure 66. Bed 1: Red gravel; Bed 2: Gray sand; Bed 3: Massive brown sand; Bed 4: Laminated tan silt and gray sand; Bed 5: Massive diatomaceous silt; Bed 6: Jointed sand.

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numbers. The foreshaft was recorded originally by Hester as artifact #10. In his report, Hester observed that all the diagnostic projectile points found in the brown wedge were Folsom, and he added that the Plainview, Agate Basin, and Clovis points were found by amateurs and reported to him as having come from the brown sand wedge (Hester 1972:66).

Given this, it should be remarked that the Clovis point that appears on the profile in the upper section of the brown sand unit is artifact # CO-5 in Hester's original figure. The label "CO" denotes that the object was part of the Collins collection. Jesse Collins was a local amateur who collected artifacts independently of Hester and Warnica's excavations. Consequently, this Clovis point base is most likely among the ones Hester referred to as being of less secure provenience.

Once we exclude the artifacts collected by Collins because of their dubious provenience (one Clovis and two Folsom points recorded in black in Figure 2), inspection of the profile indicates that all other diagnostic projectile points recovered in the brown sand unit were Folsom (recorded in white in Figure 2). This stratigraphic unit also yielded the foreshaft under consideration in this article. The foreshaft was originally recorded by Hester in the catalog listed in the appendix of his Blackwater Draw volume as a bone tool, field number 10. Among the projectile points visible on the profile and on the plan view, artifact 1A is of particular significance to the question of the cultural affiliation of the foreshaft. It is a Folsom point in close vertical and horizontal proximity to the foreshaft. This is the only projectile recorded on the profile for the lower portion of the brown sand unit. Three additional Folsom points were plotted in the upper part of that stratigraphic unit.

The profile seems to point to possibly two archaeological zones in the brown sand: one upper component was found in a zone of dense caliche nodules; a lower component was found with the bison skull, mandible, vertebra, and radiuses; one Folsom point; and the foreshaft. The component above this is clearly established as Folsom, by means of the three aforementioned points.

Considering the paucity of contextual information, it is not possible to evaluate whether the artifacts and bones were in primary position or, as Hester suggested, redeposited by flood activity. Consequently, in the absence of field records for the excavations in the Blackwater Draw Museum collections, Hester's map and profile are the most secure (and only) source regarding the stratigraphic context and, therefore, the cultural affiliation of the foreshaft. This evidence strongly points toward a Folsom origin.

Description

The rib foreshaft is part of the Blackwater Draw Museum collection (catalog number LA3324.32026). For the purpose of this study, it was digitized with an EinScan Shining SP 3D scanner, which is a structured-light scanner, equipped with a white light source and two monochrome cameras. All measurements of this artifact were taken from a 1:1 scale 3D model given that these types of measurements have been demonstrated to be at least as accurate as those taken from actual artifacts (Magnani et al. 2016; Morales et al. 2015; Porter et al. 2019). The artifact is made on a segment of bison rib (*Bison* sp.). The remaining section has an overall length of 260 mm, and it currently bears a slight curvature. It terminates in a break on its widest end, where it attains a maximum width of 29 mm and a thickness of 12.3 mm. This break does not appear to be intentional. The other end would have served as the distal end of the foreshaft—the one fitted with a projectile point.

The distal portion originally had two tabs forming a slot in which the projectile point would be hafted (see Figure 3). However, only one hafting tab remains (on the external surface of the rib). The second tab, which would have been on the internal surface of the rib, is broken, and it has taken a roughly triangular chip of the interior surface with it. The existing tab is 29.5 mm long, 21.6 mm wide at its base, and has a maximum thickness of 7.4 mm. The tip is rounded and has a "nibbled" appearance (see Figure 4). The surface at the bottom of the hafting slot between the tabs is concave and rounded. This point, at the base of the slot, has a width of 21.6 mm and a thickness of about 14.5 mm. Examination of the artifact revealed faint traces of what appears to be surface polish (evidenced by a low shine). This shine was observed macroscopically and was not restricted to any particular portion of the tool. It is unclear from our brief examination what caused it and whether this polish originated prior to the artifact's discard. In addition, sporadic evidence of red ochre coating is also visible on the surface of the tool. Similarly, red ochre is also present on many of the lithic

Figure 3. Close-up view of the tip of the foreshaft, showing the broken tab. (Color online)

Figure 4. Close-up view of the tip of the foreshaft, showing wear and rounding visible at the end of the remaining tab. (Color online)

artifacts excavated by Hester at locality 4 as well as on the artifacts collected by Collins nearby (including the Clovis base mentioned earlier, which is currently in the Blackwater Draw Museum collections).

Initially, the rib was recognized as a tool by Hester, who believed it could have been a pressure flaker (Hester 1972:135). We agree on this function, but it is important to point out that this is likely the last function of the object. Artifacts' lives are the result of dynamic processes that, in this case, probably included recycling (see Schiffer 1972; Sellet 1993). After one tab broke, the rib could not function as a foreshaft anymore without sacrificing significant length. It was then salvaged and repurposed. It is not clear if the remaining tab was still intact at this point or if it had been damaged as well. Regardless, it most likely was formerly longer than its current state. Although the attribution as a flaker is credible, the rib could have also served as a polishing or rubbing instrument of some sort. A future use-wear analysis might answer questions about its final uses.

The shape of the proximal end of the foreshaft cannot be reconstructed as no evidence of its original features remains. A bevel is likely, but other techniques could have been implemented to attach the foreshaft to the main body of the dart or spear.

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In its current state, the rib exhibits a natural curvature. That curvature may have returned after deposition. Similar prehistoric and modern examples of weapon parts made of bone, antler, or ivory that have retaken their natural curvature have been documented in archaeological and ethnographic collections from the Arctic (see McCartney 1984:Figure 5l, Figure 6A, Figure11k–m, o–q; Murdoch 1892: Figure 227, Figure 230; Nelson 1899:Plate LIV3, Plate LIV5, Plate LIX8, Plate LIX10-11). To be used as a foreshaft, the bone would have needed to be at least partially unbent (a slight curvature may not impede its use as a weapon). Although selecting ribs for manufacturing foreshafts' naturally straight sections may have been preferred, archaeological experimentation has shown that bone and antler can be worked easily with stone tools or straightened after soaking or boiling (Osipowicz 2007; Semenov 1964:159–160). Semenov (1964:160), for example, remarked that "in contemporary peasant techniques, the softening of the bone is carried out by steaming in a damp medium at a temperature of 120°C or higher."

Discussion

Over the years, discussions of Paleoindigenous weapon delivery systems have been dominated by analyses of beveled Clovis rods and the ensuing disagreement over their use as possible foreshafts (Boldurian 2007; Boldurian and Cotter 1999; Bradley et al. 2010; Lahren and Bonnichsen 1974; Lyman and O'Brien 1999; Lyman et al. 1998; Pearson 1999; Stanford 1996). Although most beveled rods were found in caches (e.g., Anzick and Richey Roberts), one sample from Blackwater Draw was recovered in direct association with mammoth remains, suggesting it functioned as a weapon part. However, beveled rods vary in size and form as well as in the raw materials used in their manufacture and, consequently, may not have served a single purpose. This is reflected in the variety of scientific opinions regarding their function. Wilke, for instance, suggested that the angle of the bevel was unsuitable for hafting Clovis points and argued that the rods were pressure flaking tools (Wilke et al. 1991). Gramly (1993) proposed another nonweapon function and argued that they were components of composite sled shoes. Lyman and O'Brien favor their use as knife handles (Lyman et al. 1998), whereas Pearson proposed a clothespin system wherein two bi-beveled rods would be assembled to form a suitable foreshaft for large Clovis points (Pearson 1999). More recently, Sutton argued that the rods functioned as components of composite fishing spears (Sutton 2018).

Although the question of the function of these objects is highly putative and presently unresolved, it should be noted that in Siberia, bone and ivory points have been recovered in association with mammoth remains (Nikolskiy and Pitulko 2013; Pitulko et al. 2004), and they were clearly used as hunting implements. Nikolskiy and Pitulko (2013), for example, discuss a series of human predation-related injuries visible on animal bones from the Yana RHS site. Among them, one mammoth scapula retains a thin ivory splinter located between larger stone point fragments. This vestigial evidence is probably a portion of a shaft that was originally tipped with a stone point. A similar injury on a North American mastodon from Manis (WA) was recently reinvestigated via sophisticated 3D microscanning, and according to Waters and his colleagues (Waters et al. 2011, 2023), the splinter embedded in the vertebra is the tip of a projectile made from mastodon bone.

All in all, the reliance on such weapons to complement stone points by Paleoindigenous hunters should not be surprising, especially considering the common occurrence of sagaies (osseous points) in the Paleolithic archaeological assemblages of Europe, for instance, or the rich ethnographic record demonstrating the use of bone and antler projectiles under varied environmental conditions from the Arctic to Africa and Australia. This begs the question why these tools are not more abundant in Paleoindigenous contexts. The answer could lie in identification (which is the nature of this article) or in differential prey choice, hunting strategies, and possibly in preservation bias.

In North America, bi-beveled rods are exclusive to Clovis, but single beveled rods have been found in a variety of contexts. Frison and Stanford (1982) reported five items believed to be part of bone projectile points from the Folsom level at the Agate Basin site. Two of these belong to the same artifact, and once lined up, they reconstruct a 25 cm long specimen. Another bone point was recovered at the nearby Sheaman locality (Frison and Stanford 1982). The Sheaman specimen was long believed to be made of ivory and to be Clovis in age, but it has since been shown to be antler and about 10,300 BP old

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(Waters and Stafford 2007, 2014). The cultural affiliation of the artifact is ambiguous; however, the site is most likely Agate Basin (Sellet 2015). Another object originally attributed to the Cody complex from the Lindenmeier site (Holen and Holen 2009; Kornfeld et al. 2021) is now believed to have been recovered at the Hell Gap site, also from an Agate Basin context (Kornfeld et al. 2021).

From this quick overview, it is plain that the use of ivory, osseous, or antler points is not exclusive to Clovis. In fact, Wygal and his colleagues emphasize that in Alaska, the beveled ivory rods from Shaw Creek predate the Clovis tradition, making them the oldest known examples of osseous rod technology in the Americas (Wygal et al. 2021).

These fragmented bits of data establish a long tradition of the use of ivory, bone, and antler as armament parts among North American Paleoindigenous groups. However, most of these objects were used as projectile tips. Beyond the circumstantial evidence provided of Clovis rods, the archaeological record of specific hafting elements is thin. At the Mill Iron site, in the Goshen component, Frison (1990; 1996) describes a mammoth rib bone modified with a tapered hole at one end, which he interprets as a haft component (Figure 5A). The piece is broken at both ends but still retains evidence of a drilled conical hole. Frison suggests that it would have been used to attach wooden foreshafts to the end of a

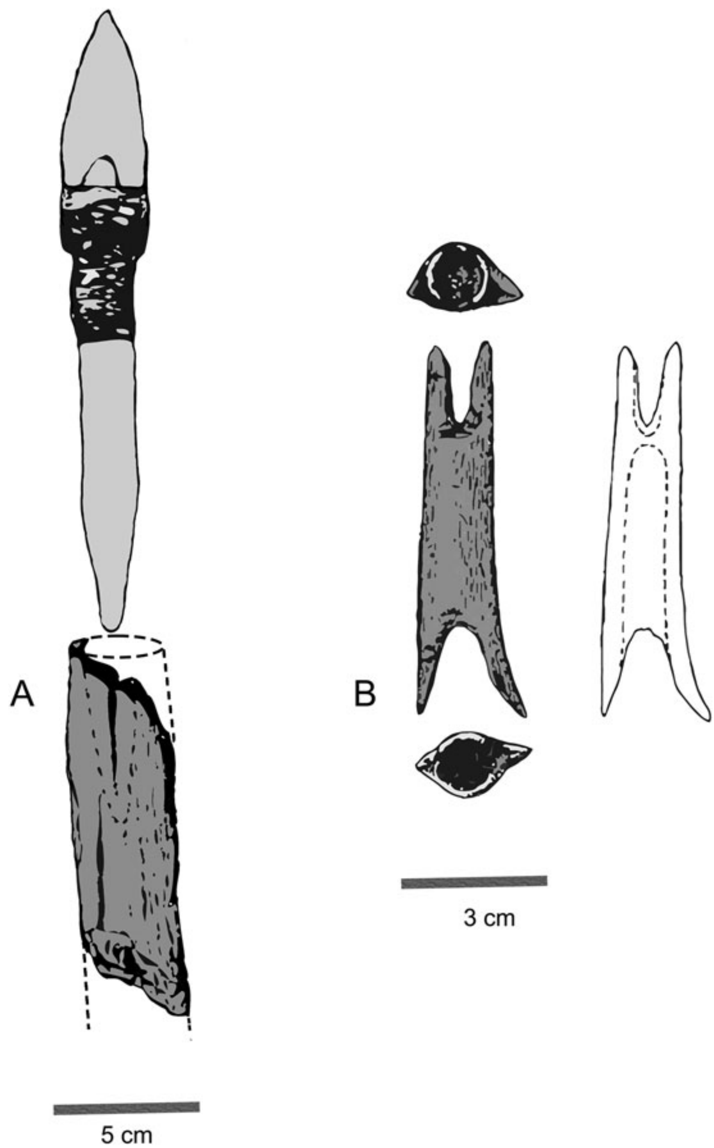

Figure 5. Two Paleoindigenous hafting implements: (A) Mill Iron mammoth rib main-shaft socket, redrawn after Frison (1996); (B) foreshaft from Indiana, redrawn after Stanford (1996).

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main shaft. Similarly, Stanford (1996) provided a short discussion of an 8,000-year-old foreshaft or haft element collected from a peat bog in Indiana (Figure 5B). The object is made of antler, with a split nock on one end for inserting a projectile point, and a drilled round socket for afixing the foreshat to a main shaft on the other extremity. That bit has two extending tangs flaring outward. According to Stanford, these features are reminiscent of a technique used to attach harpoon heads to a wooden shaft in the Arctic, and they may have served a similar function. Finally, it is necessary to mention a spectacular specimen recovered from an ice patch 3,000 m asl in Wyoming (Lee 2012). This uniquely preserved artifact is a wooden dart foreshaft that dates to approximately 10,400 cal BP. The foreshaft, which is unusually long, at 1.07 m, has a notched distal end for hafting a projectile point, three parallel marks (interpreted by Lee as ownership marks), and a proximal end that terminates in a symmetrically tapering cone approximately 10 cm in length.

As demonstrated by this brief summary of archaeological finds in Paleoindigenous contexts, the record for foreshafts is sparse and certainly insufficient to extrapolate an archetypical shape. Furthermore, none of these objects pertain directly to the Folsom period, which is the most relevant to evaluating the Blackwater Draw foreshaft. To that end, it should be noted that the Mill Iron Goshen camp site that produced the mammoth rib bone has been redated by Waters and Stafford (2007) to 10,305 ± 15 BP, well into the Younger Dryas, and in the range of Folsom. However, this complicates the attribution of the artifact to that period, given that mammoth bones could have been procured only through scavenging old carcasses and not through direct predation. Other more reliable and predictable sources of bone would have been available then, precluding the need to recycle old ones.

In the absence of an obvious Paleoindigenous foreshaft for understanding the hafting process, archaeologists have resorted to experimentation and replication studies to model such objects. Frison led these efforts with his now classic 1984–1985 exploration of the effectiveness of Clovis points on African elephants, for which he used experimental Clovis points (manufactured by Bruce Bradley) mounted in notched wooden foreshafts and inserted into a drilled main shaft (Frison 1978, 2004). This was not Frison's first attempt at the project; a few years prior to the African project, he had already experimented with hafting Hell Gap points both in notched foreshafts and socketed ones (Frison 1974) and thrown them into a mature cow carcass.

Many technological studies of Folsom collections have emphasized the production process of the Folsom point (Crabtree 1966; Flenniken 1978; Winfrey 1990), but little attention has been given to the rest of the weapon delivery system. This led Ahler and Geib (2000) to explore the role of the flute as a design element. They proposed a hafting system in which the Folsom point could be moved up in the foreshaft as it wore out, not unlike a modern snap-off box cutter knife (Figure 6). They stated,

> The original, unused Folsom point was fitted in a split, elongated haft. The wood shaft was fashioned with nearly flat faces that fit snugly along the length of the flute scar. The haft could be either a partially split, single piece of wood, or two separate pieces, the essential feature being facial contact rather than basal contact with the stone point [Ahler and Geib 2000:807].

High maintainability (sensu Bleed 1986)—the ability to preserve the efficiency of the weapon delivery system as the projectile wears out—was seen as a means to conserve raw materials. Ahler and Geib further reasoned that the latter was an advantageous organizational feature given the inferred high mobility of Folsom groups (for similar arguments, see also Guarino and Sellet 2019; Hofman 1999, 2003; Sellet 2013). Although Ahler and Geib's haft reconstruction is compelling, it is important to note that no such hafting elements have ever been recovered and, accordingly, the design should be considered hypothetical.

Another convincing design has been proposed by Osborn (1999), who based his reconstruction on a series of generalizations regarding hunter-gatherer technology at the global level. Osborn was influenced by Oswalt's (1973) cross-cultural analysis of subsistence-related tool kits. Osborn argued that Paleoindigenous groups on the Plains occupied a wood-scarce environment that would favor the use of bone or antler. He then devised a bone or antler socket with a slotted extremity to fit a

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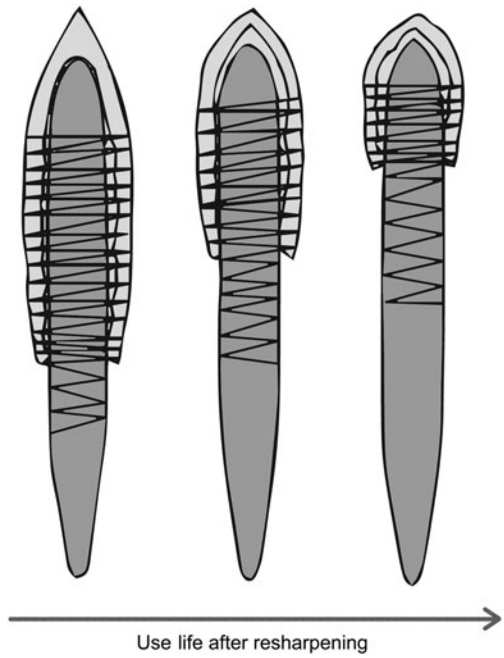

Figure 6. Ahler and Geib's interpretation of a Folsom foreshaft, where the point is shifted up as it becomes shorter (redrawn from Ahler and Geib 2000).

Folsom fluted point snugly (Figure 7). The clamping force and the large contact area between the foreshaft and the flutes eliminate the need for binding, therefore facilitating penetration of the projectile into the prey. Osborn added,

> These antler foreshafts could, then, be quickly armed with sharp points before the prey animal(s) were attacked. Atlatl and spear shafts fashioned from high quality wood, as well as antler foreshafts and sockets for foreshafts, would have probably been the "curated" technounits in Paleoindian technological systems [Osborn 1999:204].

We would like to argue that the Blackwater Draw foreshaft displays several of the purportedly ideal features incorporated into both Ahler and Geib's and Osborn's models. For the purpose of this demonstration, we printed a 3D model of the Blackwater Draw rib foreshaft with the tabs reconstructed (Figure 8). We extended the existing tab to account for the damage resulting from its use as a polishing tool or as a pressure flaker, and we fully restored the broken tab.

Figure 8 shows the foreshaft with a full-size Folsom point (A–C) and a smaller Folsom point (D–E) inserted in the slot. In both cases, only the tip and lateral edges protrude, thereby satisfying the requirements of a large contact area between the foreshaft and the point inherent in the Osborn model. Leaving only a small portion of the tip exposed further protects against bending fractures (Ahler and Geib 2000). Additionally, just as in the Ahler and Geib model, the point could be moved distally in the foreshaft after resharpening given that we reconstructed full-length hafting tabs. A shim of some sort—such as a piece of wood, bone, or other material—could then be inserted into the slot as a spacer to account for the now missing length (see Figure 8F). This is an idea that Ahler and Geib (2000:814) attribute to Marvin Kay.

Unlike Osborn, however, we believe that points would have been secured into the foreshaft with sinew. We base this assumption on the presence of lateral grinding on many Folsom points. Whereas Osborn (1999) interprets the grinding as a way of preventing fracture initiation and the breakage of the point, we feel that it is better explained as a means of preventing the point from cutting through its sinew bindings. Significantly, although many Folsom points show evidence of lateral grinding, the base itself is often left unground. It therefore appears that the design does not require particular attention in this area.

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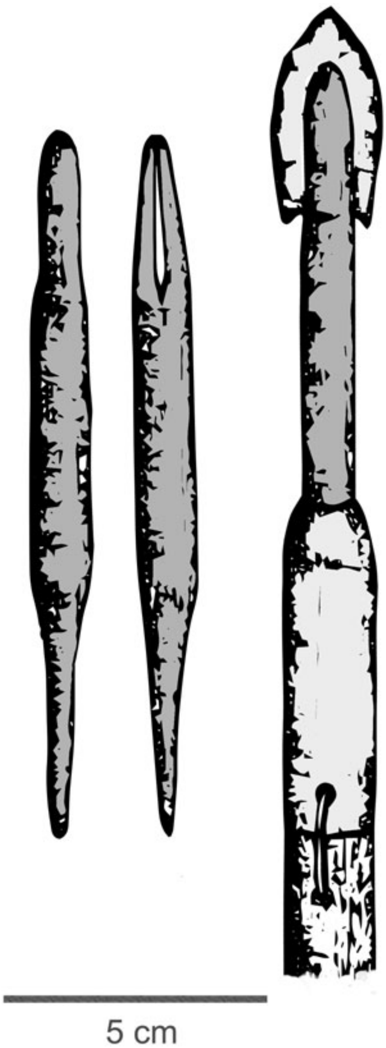

Figure 7. Osborn's reconstruction of a Folsom foreshaft (redrawn from Osborn 1999).

Our reconstructed foreshaft is particularly suited for hafting projectile points of diverse sizes and therefore allows quite a bit of flexibility. It can be used to fit worn out or broken points, after their tip is refurbished or resharpened. It could also accept initially small and narrow projectile points. This flexibility may have been essential to the organization of Folsom technology. Guarino and Sellet (2019), for example, have argued that Folsom knappers likely progressively switched to smaller flakes for point manufacture when conserving raw materials and subsisting solely on transported blanks.

Hunzicker (2008) replicated and tested different hypothetical Folsom foreshaft designs (Figure 9). These included five morphologies: (1) a simple slotted foreshaft (Frison 1989; Musil 1988; Osborn 1999); (2) a two-piece split, as proposed by Ahler and Geib (2002); (3) a small wooden "key" to secure a point against the gently beveled distal end of a foreshaft, as suggested by Bement (2002) and Boldurian and Cotter (1999); (4) a socket with a slot in the distal end to hold the point (Boldurian 2008; Boldurian and Cotter 1999; Stanford 1996); and (5) an amalgam of the previous designs with two keys forming a wedge on the distal end of a foreshaft component. After launching a complete sample of 25 hafted Folsom points into Holstein cow carcasses by means of a calibrated crossbow, Hunzicker concluded that the breakage patterns produced by each design were not significantly different from one another and, consequently, that there was "no way to use these data for meaningful

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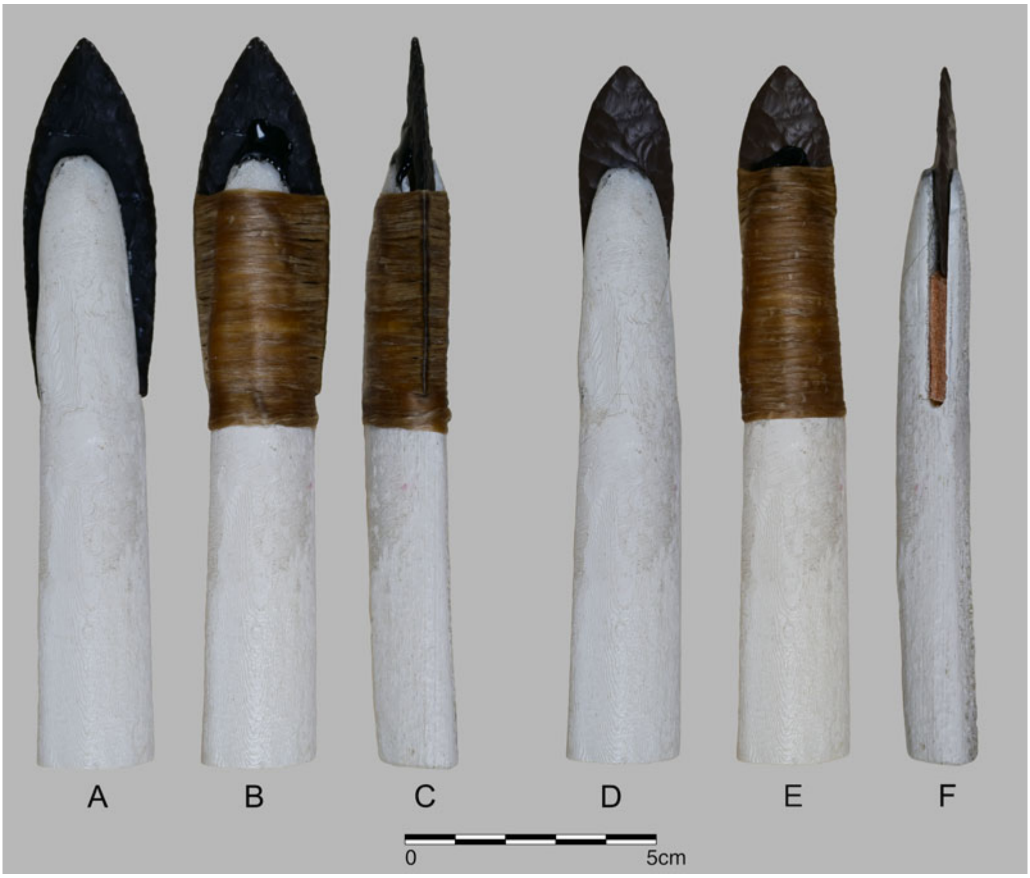

Figure 8. Reconstructed foreshaft. We reconstructed the damaged tabs of the Blackwater Draw artifact and printed a 3D model. The model was then fitted with a cast of a (A–C) large and a (D–F) smaller Folsom point. (Color online)

comparison with ancient Folsom points" (Hunzicker 2008). Altogether, his experiment demonstrates that because of equifinality, it may not be possible to identify the type or even the main characteristics of Folsom hunting weapon(s) with experimental reconstruction alone. Experimental archaeology can help test design ideas and point in the right direction, but ultimately, the burden of proof requires finding a preserved archaeological specimen. This is what this report accomplishes.

Conclusion

The discovery of a rib bone foreshaft in the Folsom Blackwater Draw collections fills an important gap in our knowledge of early Paleoindigenous groups. It draws needed attention to the interconnectedness of the lithic system and other aspects of prehistoric technology. Bone, antler, and wood are raw materials that were readily available to these groups, yet Folsom archaeologists have regularly made lithic tools the focal point of their reconstructions of past adaptations. Human mobility, for example, is frequently equated directly with proportions of lithic raw materials at any given archaeological locality. However, because projectile points were only one piece (albeit an important one) of the hunting gear, our understanding of their role in past technological organizations remains deficient without knowledge of the complete weapon delivery system. Assessing how points were hafted could give us insights into the flexibility (or lack thereof) embedded into Folsom subsistence practices. Were bone points only a substitute for stone tips in situations of extreme lithic raw material depletion, or did they provide one more option in the everyday tool kit? Could they easily be fitted into a weapon delivery system that regularly accommodated Folsom points? Determining if foreshafts were specialized designs or whether they could function with multiple types or sizes of projectile points is critical

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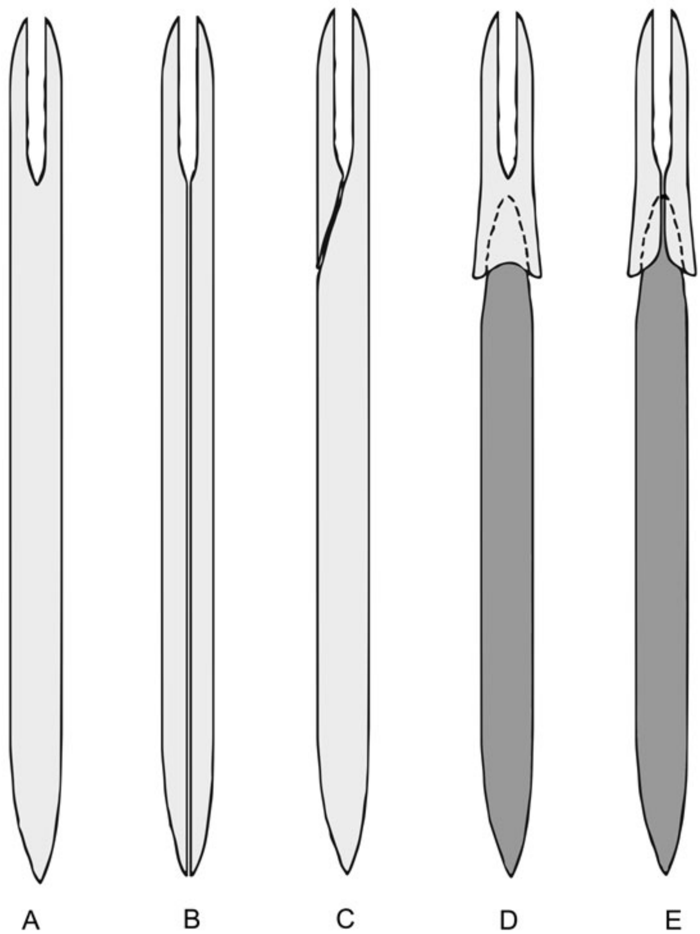

Figure 9. Hunzicker's reconstructed Folsom foreshafts (redrawn after Hunzicker 2008): (A) one piece slot; (B) full split; (C) bevel with key; (D) hafting socket; (E) double bevel pinch.

to understanding Folsom resource extraction strategies. It can, in particular, help untangle tool replacement decisions, a requisite step toward modeling planning depth and landscape exploitation.

Ethnographic observations have repeatedly demonstrated that traditional hunters rely on a variety of projectile designs to kill their prey. The designs are adapted to prey size, type, or behavior. There are no a priori reasons to believe that Paleoindigenous people behaved differently, yet we continue to project a Ptolemaic model of technological systems—one that sketches the Folsom universe as revolving around stone tools. Although there are many possible approaches to remedying this limitation, this study shows that there is tremendous potential in revisiting museum collections to expand and refine our understanding of these ancient adaptive strategies.

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