Chapter 15
A Review of Late Pleistocene North American Bone and Ivory Tools

Michael J. O'Brien, R. Lee Lyman, Briggs Buchanan, and Mark Collard

Abstract Osseous (bone and ivory) rods dating to the Early Paleoindian period (ca. 13,300–11,900 calendar years before present) have been found over much of North America. Previous researchers have attributed several possible functions to these artifacts, including use as projectile points, as foreshafts, as pressure-flaker handles, as sled shoes, and as levered hafting wedges. Considering the important link that osseous rods provide between the late Pleistocene cultures of North America and the Upper Paleolithic cultures of Europe and Asia, it is crucial that archaeologists define the range of variation and possible functions represented in the North American osseous rods. In this chapter we provide an up-to-date review of the distribution of late Pleistocene osseous rods across North America; describe the range of variation in morphology and attributes associated with this sample; and discuss the possible range of functions represented.

Keywords Bone rods • Ivory • Early Paleoindian period • Function

Introduction

Bone, ivory, and antler tools dating to the Early Paleoindian period (ca. 13,300–11,900 calendar years before present [cal BP]) have been found over much of North America, especially the Pacific Northwest and Columbia Plateau, the northern Plains, and Florida. Researchers have attributed numerous functions to these tools, including use as projectile points, foreshafts for spears or darts, shoes for sled runners, handles for pressure flakers, levered hafting wedges, fish hooks, atlatl nocks, billets, awls and punches, and shaft wrenches. Considering the significant functional link that the tools might provide with the Upper Paleolithic cultures of Europe and eastern Asia, it is important that archaeologists define the range of variation and possible uses represented in the North American sample. Here our interest is primarily on bone and ivory tools, which represent by far the largest percentage of Early Paleoindian non-stone tools recovered to date. Our discussion builds on earlier work (e.g., Lyman et al. 1998; Pearson 1999; Webb and Hemmings 2001; Redmond and Tankersley 2005), but it is not an exhaustive survey of all known tools, many of which still have not been measured and described in the public record.

Background

Archaeological interest in early prehistoric bone and ivory tools from North America can be traced back to 1937, when Cotter (1937:14) reported the discovery of a "cylindrical shaft of bone" in association with mammoth remains in the excavations at what became known as Blackwater Draw Locality No. 1, just outside Clovis, New Mexico (Hester 1972; Saunders and Daeschler 1994; Boldurian and Cotter 1999). There actually were two specimens, found within 2 days of each other (Boldurian and Cotter 1999). Within a few decades, similar items were found in Saskatchewan, Canada (Wilmeth 1968), and the states of Alaska (Rainey 1939, 1940), Washington (Daugherty 1956; Irwin and Moody 1978), Oregon (Cressman 1942, 1956), California (Riddell 1973), Montana (Lahren and Bonnichsen 1974), and Florida (Jenks and Simpson 1941).

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Many of the early discoveries prompted suggestions of typological similarity among the specimens, leading to speculation that the ages of the newly discovered pieces were similar to that of the Blackwater Draw specimens. For example, specimens from Alaska were said to be "similar [to] long bone points in direct association with mammoth bones" at Blackwater Draw (Rainey 1939:394), and the specimens from Blackwater Draw were said to be "very much like the [Saskatchewan] specimen" in terms of "width and thickness" (Wilmeth 1968:101). When Cressman consulted Cotter on the typological identity of some specimens recovered from southern Oregon, Cotter thought one of them was identical to the specimens from Blackwater Draw (Cressman 1942). Similarly, Jenks and Simpson (1941:318) stated that their specimens from Florida were "typologically the same" as those from Blackwater Draw.

Thus by the early 1940s, numerous bone and ivory tools from varied contexts across the United States were being assessed as "belong[ing] to a long extinct culture, probably of closely approximating age, namely, of late glacial or early post-glacial time" (Jenks and Simpson 1941:318). These tools became a hallmark artifact of the Clovis culture (e.g., Sellards 1952) and remain so today (e.g., Bonnichsen et al. 1987; Pearson 1999; Redmond and Tankersley 2005; Stanford and Bradley 2012), albeit not as well documented and studied as the thin, fluted projectile points that gave the culture its name (Fig. 15.1) and which are sometimes found in caches alongside bone shafts, or rods (Lahren and Bonnichsen 1974; Gramly 1993).

Despite this status, there are relatively few radiocarbon dates that directly tie the tools to the Clovis period (13,300–12,800 cal BP [Haynes 2002; Collard et al. 2010]). Two bone rods from Sheriden Cave in north-central Ohio (Redmond and Tankersley 2005) were recovered from a cultural horizon with radiocarbon dates in the 12,900–12,500 cal BP range; bone collagen from one of the specimens was subsequently dated to 13,025–12,925 cal BP (Waters et al. 2009). Similarly, two bone-collagen samples from bone rods found at the Anzick site in Montana yielded dates in the 13,000–12,800 cal BP range (Morrow and Fiedel 2006), which mirrors the range of a bone-collagen sample from an ivory rod from Sloth Hole in Florida (Hemmings 2004).

However, it is clear that not all bone and ivory tools date to the Clovis period. For example, a bone rod from the Sheaman site in Wyoming (Frison 1982), which was long assumed to be Clovis in age based on context and radiocarbon dates (Haynes et al. 2004), may actually postdate Clovis based on three collagen dates on the rod that average 12,175 ± 155 cal BP (Waters and Stafford 2007). These dates place it in the Folsom period (ca. 12,800–11,900 cal BP). Three rods from the Agate Basin site in Wyoming (Frison and Zeimens 1980; Frison and Craig 1982) also date to the Folsom period. Three specimens from the Lind Coulee site in Washington may date several thousand years later (Daugherty 1956; Irwin and Moody 1978), but recently obtained AMS dates on collagen from associated bone suggest they may be as old as 12,000–11,200 cal BP (Craven 2004). Bone and ivory tools are also known from sites in Alaska (Rainey 1939; Ackerman 1996; Holmes 1996) that predate and postdate Clovis.

Today, Paleoindian bone and ivory tools are known from at least 11 continental U.S. states and the province of Saskatchewan (Fig. 15.2). Their distribution is highly uneven, with over half the known specimens—many of them in private collections (Dunbar and Waller 1983; Wagers 1986)—coming from Florida. There is no reason to suspect that the distribution is attributable to anything other than preservation. The large number of specimens from Florida is tied to the postglacial rise in sea level that submerged low-lying archaeological and paleontological sites located in and around Florida's extensive karst system—Page-Ladson (Webb 2006) and Sloth Hole (Hemmings 1999, 2004), for example—thus preserving Paleoindian organic remains (Willis 1988; Dunbar et al. 1989; Hemmings 1999; Webb and Hemmings 2001; Bradley et al. 2010). Compared to the sample of known Clovis points from North America, which ranges into the thousands (Anderson et al. 2010), the extant sample of osseous tools is "severely impoverished" (Redmond and Tankersley 2005:504).

Variation in Form and Function

One noticeable characteristic of North American rods is the presence of beveling on one or both ends, the obvious conclusion being that bevels had something to do with how the tools were used. Cotter (1954), for example, referred to the rods as "beveled bone foreshaft portions or spear tips," which he assumed were derived from the familiar *sagaie*, or javelin, points of bone or reindeer horn from the European Upper Paleolithic. Similarly, Jenks and Simpson (1941) referred to the bone rods as "beveled artifacts" and thought that at least one of the three Florida specimens they described represented a "hunting point." Cressman (1942) referred to his specimens as bone "points" or "foreshafts," later describing one specimen as a "long beveled end projectile point" because it was "found in the lower left abdominal part of [a human] skeleton"; the beveled end was said to be "for hafting to a shaft" Cressman (1956:431).

The emerging designation of these artifacts as foreshafts received some formality in a report by Lahren and Bonnichsen (1974) on the Anzick materials from Montana (Fig. 15.2)—a deposit of flakes, bifaces, bone rods, and eight Clovis points buried in a collapsed rock shelter. The authors provided a description of the bone rods—two complete and nine fragmented, together representing an assemblage of perhaps as few as four to six rods (Jones 1996) or as many as eight

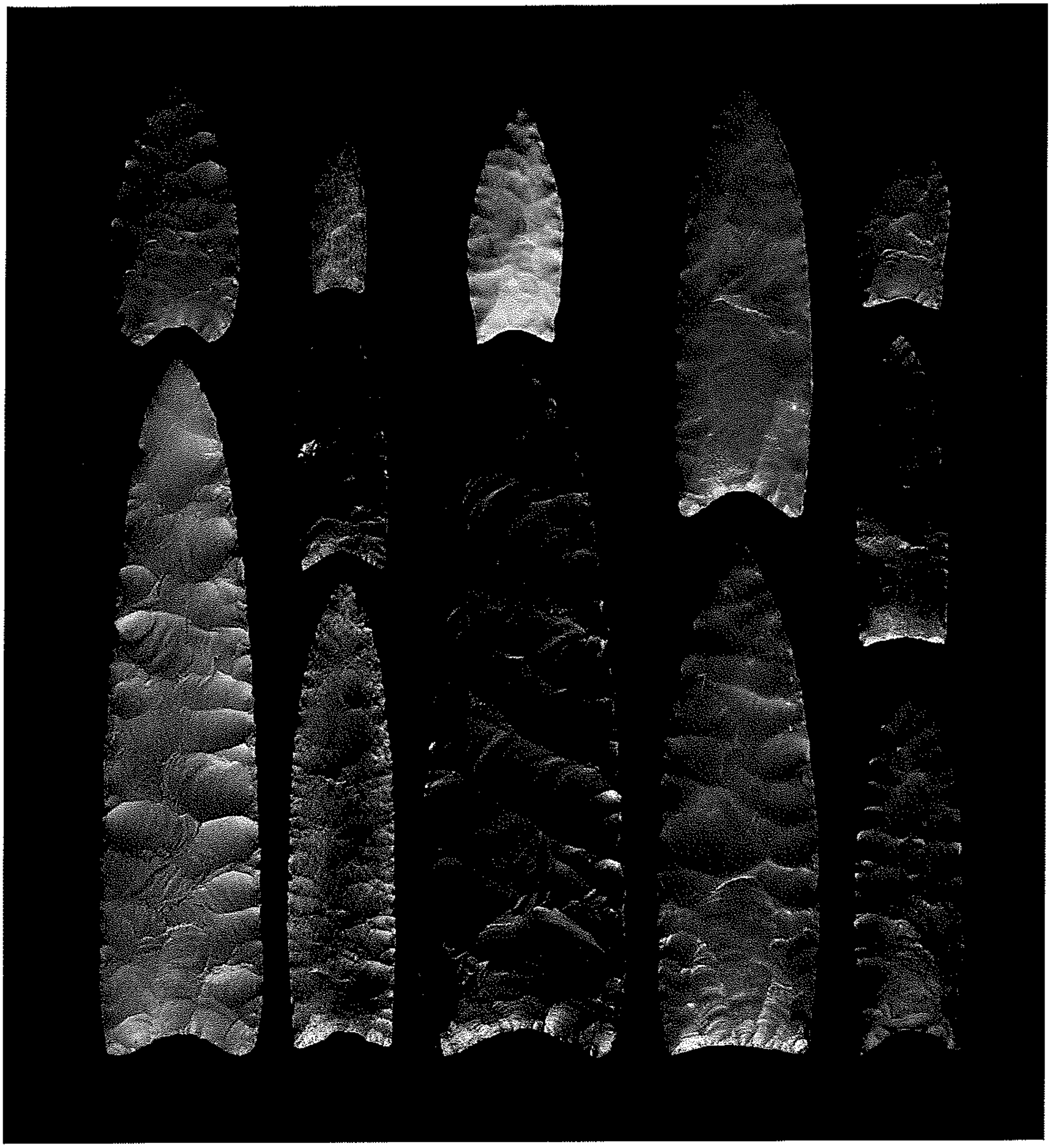

Fig. 15.1 Clovis points from various North American sites. Photo by Charlotte D. Pevny; courtesy Michael D. Waters

(Lassen 2005)—and a model of how they thought the specimens served as foreshafts to which Clovis points were hafted. Frison (1982:156) later stated that the "true function of [these] objects…remains an open question; they are postulated as having been both foreshafts and actual projectile points." Still later, Wilke et al. (1991) argued on the basis of experimental work that the Anzick specimens were handles to which an antler bit was hafted, thereby producing a composite tool for pressure flaking.

Another site—East Wenatchee (also known as the Richey–Roberts Clovis cache) in eastern Washington (Fig. 15.2)—received considerable archaeological attention in the late 1980s when a cache of 14 large Clovis blades and 14 bi-beveled bone rods was unearthed in an apple orchard.

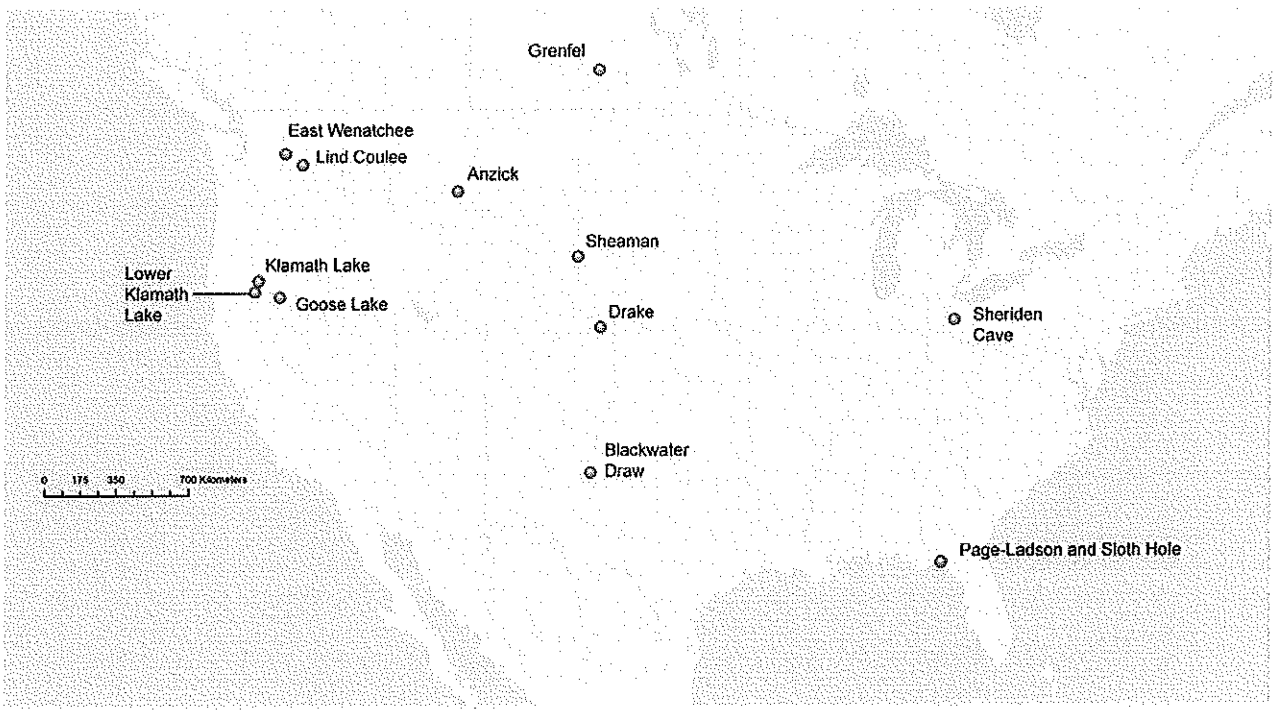

Fig. 15.2 Locations of some North American sites that have produced bone or ivory rods

Mehringer (1988a, b, 1989) indicated that it was speculative whether the rods were foreshafts, pressure flakers, or "wedges for splitting wood." Gramly (1993:8) later noted that "the rods are paired by size" and expressed a preference for the hypothesis that the size-paired sets of specimens once served as shoes for sled runners.

Part of the continuing puzzlement over what functions the beveled rods might have served originates in the fact that the two original Blackwater Draw specimens appeared similar to each other and thus were thought to comprise a single type of artifact (Cotter 1937). Some analysts later argued that all beveled rods, irrespective of geographic origin, were of the same "type" (Cressman 1942; Cotter 1954; Cressman 1956; Lahren and Bonnichsen 1974), whereas others (e.g., Riddell 1973) identified two types on the basis of whether beveling occurs on only one end or on both ends. Table 15.1 lists a sample of bone and ivory rods from several locales. Despite the fact that many data are missing—a result of the fragmentary nature of some specimens or a lack of recording—note the wide variation in measurements. Length, for example, ranges from 112 to 281 mm, maximum width from 8 to 30 mm, and maximum thickness from 10 to 22 mm. Figure 15.3 plots length versus maximum width for specimens in Table 15.1. Note that 11 of the 12 measurable rods from East Wenatchee (another rod was too fragmentary to measure and still another was left in the ground [Gramly 1993]) are in a grouping well outside that of other specimens in Table 15.1 as a result of their larger maximum widths.

Possible Functions

Given the variation in size and number of beveled ends, it perhaps is predictable that different specimens or sets thereof would have been interpreted differently in terms of their suspected function. The question begged by these observations concerns the relevance of the attributes considered for determining artifact function. We examine below several possible functions, focusing on the mechanical efficiency of particular attribute combinations displayed by the tools when serving a particular use.

Foreshafts

One function commonly found in the archaeological literature with respect to bone and ivory rods is that of *foreshaft* (e.g., Bonnichsen et al. 1987; Stanford 1991; Wilke et al. 1991)—the middle piece of a compound weapon between the projectile point and main shaft. Foreshafts should be rod-like, given the intended purpose of making retooling and game killing more efficient (e.g., Frison 1974, 1978), but why are the ends beveled? If the bevel were a mechanically critical attribute, then we might wonder why some rods are beveled on both ends and others on only one end. We doubt that this variation is the result of some rods not yet being completely manufactured or finished products. This assessment is based

Table 15.1 Descriptive data for a sample of osseous rods from North America

Specimen	Material	Length	Width	Thickness	Bevel	Bevel incised?	Bevel length†
Anzick-37	Bone		17	12	1		49
Anzick-38	Bone		19	13	1		
Anzick-39	Bone				1		48
Anzick-67	Bone	228	15	12	2?		58
Anzick-94	Bone		18	13	1		44
Anzick-95	Bone		18	13	1		44
Anzick-117	Bone		15	10			
Anzick-118/119	Bone	281	18	14	2	Yes	46/51
Anzick-120	Bone		19	11			
Anzick-122	Bone		20	13			
Anzick-123	Bone		20	14			
Florida-A	Bone	182+	12.3	12	1	Yes	58
Florida-B	Ivory	91+	8.5		1	Yes	25
Florida-C	Ivory	150.5+	10.1			Yes	
Blackwater Draw-9	Bone	252	15		2	On 2	
Blackwater Draw-10	Bone	234	17		2	On 1	
Lind Coulee-178	Bone	134	13.4		1		61.6
Lind Coulee-140	Bone	251+	16.4	10.4			
East Wenatchee-A	Bone	263	24	18	2	On 2	59/35
East Wenatchee-B	Bone	209	24	17	2	On 2	
East Wenatchee-C	Bone	252	24	18	2	On 2	70/50
East Wenatchee-D	Bone	242	29	19			
East Wenatchee-E	Bone	231	28	20			
East Wenatchee-F	Bone	190	26	18	2?	On 1	50/83(?)
East Wenatchee-G	Bone	232	30	22	1	Yes	
East Wenatchee-H	Bone	177	26	18	1	Yes	46
East Wenatchee-I	Bone	215	30	21			
East Wenatchee-J	Bone	171	27	19	1	Yes	42
East Wenatchee-K	Bone	193	28	20	1	Yes	50
East Wenatchee-L	Bone	115	13	12			
Sheaman	Ivory	203	12.1	10	1	Yes	74.7
Lower Klamath Lake	Bone	250±	13±		1		
Klamath Lake	Bone	190	15	12	1	No(?)	70
Saskatchewan-1	Bone	207	15	12.5		Yes‡	
Goose Lake-1d	Bone	133	10		1		
Goose Lake-1e	Bone	168	11		1		
Goose Lake-1f	Bone	197	13		1		
Goose Lake-2a	Bone	112	8		1		
Goose Lake-2b	Bone	198	12		2		
Goose Lake-2c	Bone	180	9		2		

All measurements are in mm. See text for most references; Florida is Jenks and Simpson (1941).

†If two bevels are present, two measurements are listed, separated by "/".

‡Cut groove encircles an end, but there is no bevel

on the fact that there are other attributes of the beveled ends that have not been discussed in the literature but which could be critical to correctly determining the function of the rods. Unfortunately, bevel length is often not reported, and with few exceptions (e.g., Jones 1996; Redmond and Tankersley 2005), neither is the angle of beveling.

Lahren and Bonnichsen (1974), following earlier workers (e.g., Cotter 1937; Hester 1972), presented a model of how the bevels might have served the hafting function (Fig. 15.4). Part of this model probably grew out of Cotter's (1954) earlier-noted remark that the North American rods resembled "sagaie or javelin points" from the European Upper Paleolithic. It is true that there are some resemblances—the European specimens are beveled, and some but not all bevels of the sagaie points have a pattern of grooves (e.g., Bordes 1968, Fig. 58 #1)—but that pattern is unlike the one on most

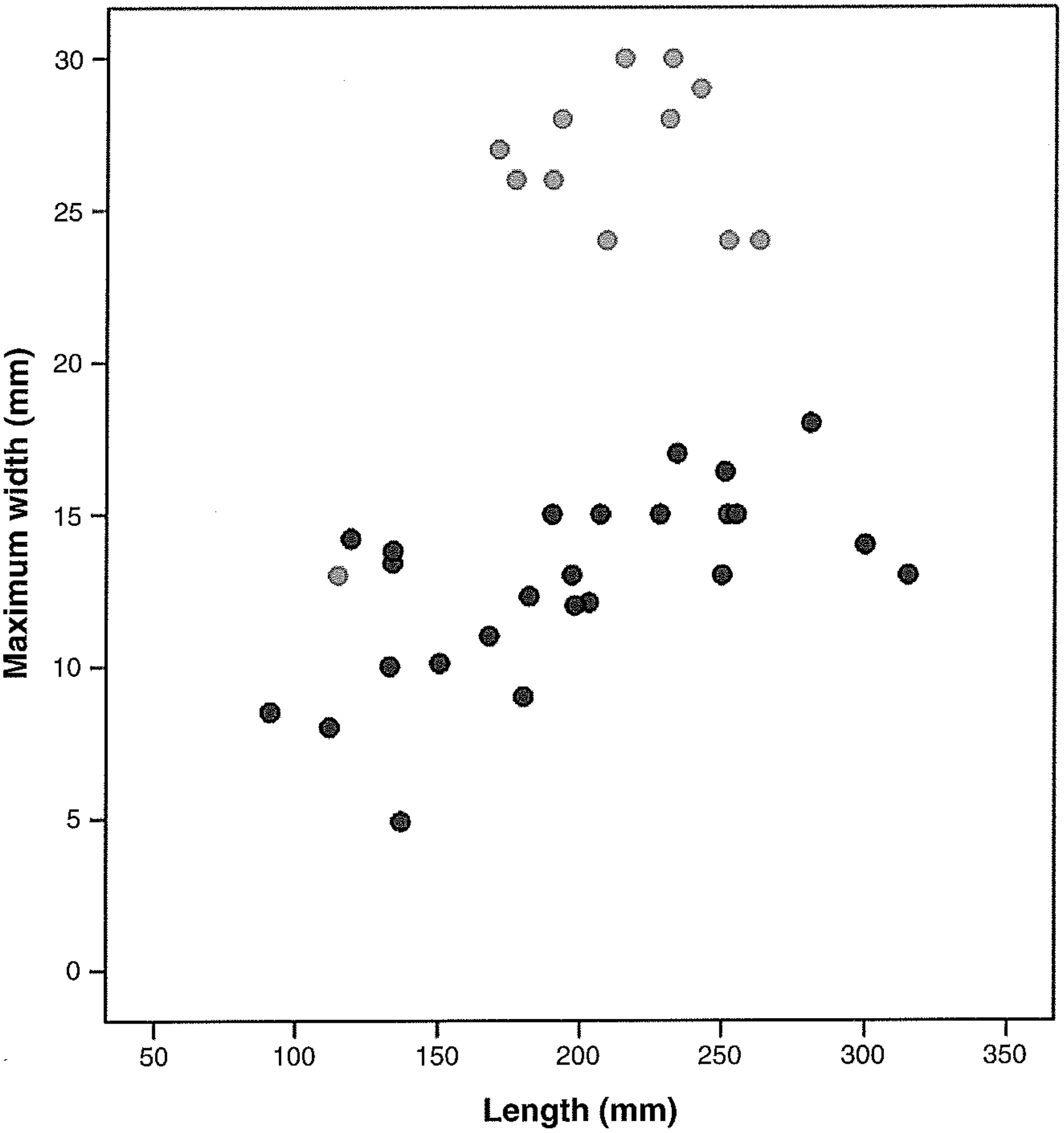

Fig. 15.3 Bivariate scatterplot of length versus maximum width for rods listed in Table 15.1. Specimens from East Wenatchee, Washington, are shown in *orange*

North American specimens. Further, unlike various North American specimens, examples of sagaie points such as those to which Cotter referred (1) all display single bevels, (2) taper from the distal end of the bevel more or less consistently to a point, and (3) have a straight rather than a convex face opposite the bevel (e.g., de Sonneville-Bordes 1963, Figs. 3 #8 and 7 #2; Bordes 1968, Figs. 55 #4, 56 #11, and 58 #2).

Experiments by Callahan (1994) indicate that a bevel-to-bevel haft works well and avoids the problem of limited penetration found with a socket haft. We note that a bevel-to-bevel haft avoids problems of penetration only if the face opposite the bevel is straight and if there is a smooth transition in diameter from the foreshaft to the shaft. Specimens from Anzick (Lahren and Bonnichsen 1974; Wilke et al. 1991)

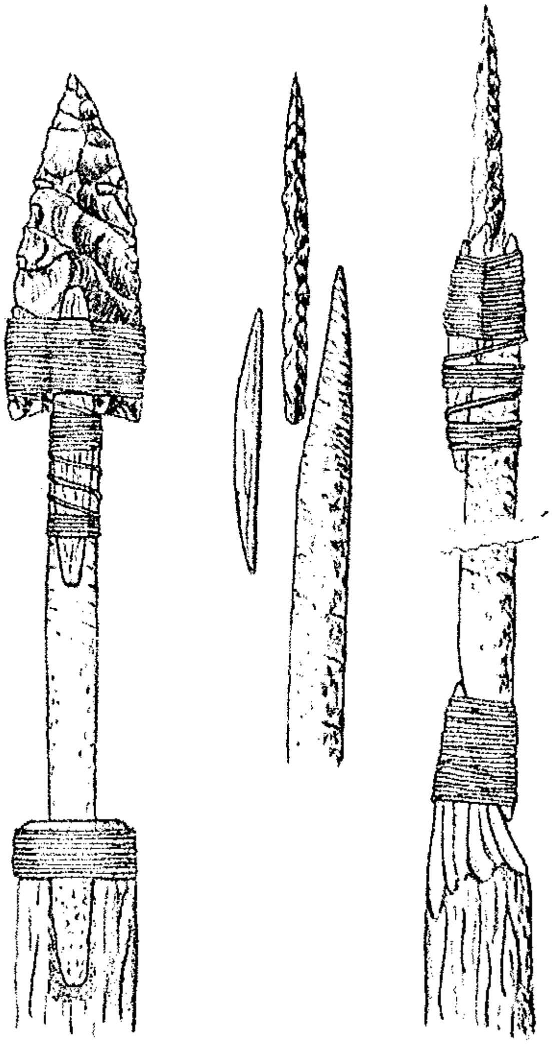

Fig. 15.4 Lahren and Bonnischsen's (1974) model of bi-beveled bone rods functioning as foreshafts

have this attribute, as does one rod from Blackwater Draw (Boldurian and Cotter 1999) and the ivory specimen from the Sheaman site in eastern Wyoming (Frison and Zeimens 1980; Frison 1982).

Lahren and Bonnichsen's model (Fig. 15.4) might be reasonable if the manner of hafting foreshafts to shafts is modified to a bevel-to-bevel haft, but there are three other attributes of their model that warrant comment. First, no bone or wood "splints" like that shown in Fig. 15.4 have ever been found. If they were made of wood, perhaps they did not preserve, but if they *were* made of wood, why were the main foreshafts made of bone? Second, the bases of Clovis points almost always were ground (e.g., Woods and Titmus 1985), which is unnecessary given the hafting model in Fig. 15.4 because the base of the point is not resting on anything. Such basal grinding would perhaps be necessary, however, if a point were hafted in and seated on the base of a wooden nock. If the base were sharp, or if there were not a strip of, say, hide between the point base and the nock base, the point would serve as an efficient wedge and split the shaft when the point met resistance during penetration. Third, experiments by Lyman et al. (1998) indicate a point hafted between a splint and a foreshaft as in Fig. 15.4 would result in poor alignment of the point, foreshaft, and shaft. Callahan (1994) used this hafting system successfully, but his version was rather different than that shown in Fig. 15.4.

Some experimenters (e.g., Frison 1974; Huckell 1982; Frison 1986, 1989; Smallwood 2015) have used as analogs wooden foreshafts (with points attached) recovered from late prehistoric contexts (Frison 1962, 1965). Frison (1989), Huckell (1982), and Callahan (1994) replicated such wooden foreshafts, hafted lithic points in a nock in the distal ends of the foreshafts, and seated the proximal ends of the foreshafts in sockets (of various shapes) in the ends of the main shafts. The replicate wooden foreshafts described by Frison (1989) and Huckell (1982) averaged 19.7 mm in diameter and ranged from 13.9 to 24 mm in diameter. The smallest one appeared to be too small (Frison 1989:769) to function properly, as it "broke in two places when used with a thrusting spear." Thus, Frison concluded that the optimum diameter of wooden foreshafts was 17–18 mm.

Stanford (1996) proposed a different foreshaft model that consists of two unique aspects. First, the bi-beveled rods are viewed as composite pieces that fit together to create a lengthened foreshaft "capable of lethal penetration into a mammoth" (Stanford 1996:45). If correct, one might wonder why some of the rod faces opposite the bevel are straight and others convex relative to the long axis of the rod (Lyman et al. 1998). Also, basic principles of geometry dictate that the angles of the bevels facing one another be identical to ensure a straight shaft. As well, we note that bone rods, even when the bevels are scored to increase friction, would be difficult to lash together and not have them come apart as a result of flexion. The second aspect of Stanford's (1996) model consists of an antler "foreshaft socket." The blunt end of an osseous rod serving as a foreshaft would sit in one end of the antler socket, which has a nock-like slot at both ends, and a Clovis point would be seated in the other end. Boldurian and Cotter (1999) proposed a similar model for the two bone rods from Blackwater Draw.

Pearson (1999) also thought of bi-beveled rods as foreshafts and proposed that two rods of equal length were glued and lashed together on their ventral surfaces around a projectile point and a main shaft. A bonding mastic was then applied to their midsections and to the cross-hatched bevels. A projectile point and a wedge-shaped shaft were then inserted into the mastic-covered "V" openings created by the facing bevels. The projectile point would have been tied to the narrower slot, whereas the shaft would have been secured to the opening with the wider angle. Lashings were then used to bind both pieces tightly around the projectile point and shaft. Parallel hatching on the surface opposite the bevels prevented the lashings from slipping during use. Depending on the manner in which the foreshaft was fastened to the main shaft, it may or may not have been detachable. Pearson (1999) proposed that the advantages of double bi-beveled-rod foreshafts over single-piece "clothes-pin" foreshafts—similar to Stanford's (1996) antler foreshaft socket—include faster repair time, high curation rate, increased resiliency under impact, and greater versatility in accommodating points of different dimensions (Pearson 1999). Unlike with regular clothes-pin foreshafts, it would be unnecessary to manufacture a whole new armature when one of the tangs broke.

Projectile Points

Some analysts (e.g., Cressman 1956; Frison and Zeimens 1980; Guthrie 1983; Stanford 1991; Redmond and Tankersley 2005; Waters et al. 2009, 2011) think some of the beveled rods from North America served as projectile points. In terms of one performance characteristic—penetration—experiments using antler, bone, and wooden projectiles indicate that antler—caribou (*Rangifer tarandus*), in particular—penetrates better than bone and that both of them perform better than wood (Butler 1980; Guthrie 1983). Penetration, however, is only one part of performance, others being the limits of material morphology, durability, and difficulty to repair. Experimental replication and use as reflected in the ethnographic record have documented other performance characteristics as they relate to flaked-stone points versus organic points (Ellis 1997; Knecht 1997; Elston and Brantingham 2002), but we are unaware of detailed studies that have focused on those same characteristics within the organic-point group (bone, ivory, and antler).

As noted in the discussion on foreshafts, European sagaie have a single bevel and taper more or less continuously to a sharp point. By far the most detailed descriptions of similar points from North America come from two bone rods from Sheriden Cave in north-central Ohio (Redmond and Tankersley (2005). Both points were made from split sections of mammal long bone. Point 1 was 134.2 mm long and had a maximum width of 13.8 mm, a maximum thickness of 10.6 mm, a bevel length of 46.0 mm, and a bevel angle of 7.0°. Point 2 (Fig. 15.5) was 119.4 mm long and had a maximum width of 14.2 mm, a maximum thickness of 11.6 mm, a bevel length of 46.9 mm, and a bevel angle of 10.5°. The beveled surface of point 1 exhibited deep, fine parallel incisions that likely were made with a chert-flake tool. On each specimen, additional fine oblique incisions occurred just distal to the beveled surface as well as on the surface opposite the bevel. On point 2, carving around the proximal end of the nonbeveled surface left a distinct node that could have facilitated the hafting of the bone rod to a foreshaft. Scanning electron microscopy of point 1 revealed minor impact damage to the pointed tip that closely matched tip damage produced experimentally on replicated Magdalenian bone points that impacted bone targets (Arndt and Newcomer 1986).

Following the methods outlined by Lyman et al. (1998), Redmond and Tankersley (2005) compared length and maximum-width measurements of complete rods from several locales, including 12 from East Wenatchee, 6 from

Fig. 15.5 Three views of bone point no. 2 from Sheriden Cave, Ohio. Note the scoring on the beveled end (*top view*) and the small purposely made protuberance on the opposite side from the bevel, which could have facilitated the hafting of the point to a wood or bone foreshaft. Photo courtesy Peter A. Bostrum, Lithic Casting Lab, Troy, Illinois

Florida, 2 from Anzick, the 2 Blackwater Draw specimens, and the 2 Sheriden Cave specimens. To this collection, they added nine complete single-bevel specimens (points) from the Upper Paleolithic Aurignacian V and Protomagdalenian levels in Laugerie-Haute rock shelter in southwestern France (Knecht 1991), which date to 26,400–24,900 cal BP. Redmond and Tankersley's bivariate plot of length versus maximum width, shown in Fig. 15.6 (top) with slight modification (a few of the specimens they included are not shown), shows that the Sheriden Cave specimens cluster tightly with the French points, as do two of the Florida specimens and the smallest specimen from East Wenatchee. The other North American specimens are longer and wider.

Redmond and Tankersley also compared maximum thickness and maximum width of the specimens for which thickness measurements were available (Fig. 15.6 [bottom]). Sheriden Cave points are more similar to the French points in terms of shaft morphometrics. The French points maintain a tight cluster of their own, with one slight outlier. Eight of the nine French specimens measure less than 11.0 mm in maximum width and less than 9.0 mm in maximum thickness. These relatively slender points are clearly set off from the larger rods, especially those from East Wenatchee, while the two specimens from Sheriden Cave are just to the upper right of the French specimens. The Sheriden Cave specimens are also similar to the Upper Paleolithic specimens

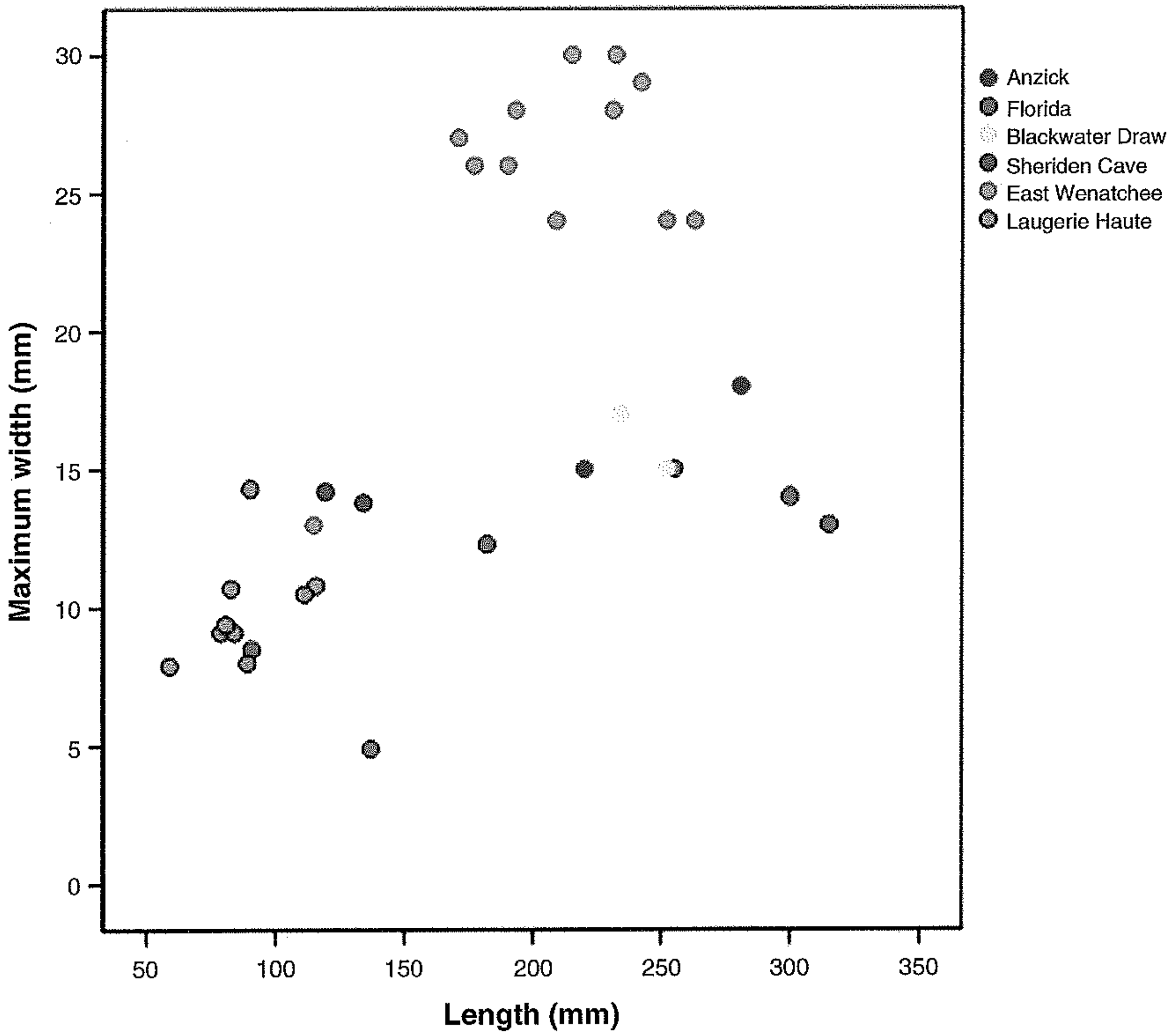

Fig. 15.6 Bi-variate scatterplots of length versus maximum width (*top*) and maximum thickness versus maximum width (*bottom*) of select osseous rods from various North American localities and from Upper Paleolithic levels in Laugerie-Haute rockshelter in southwestern France. After Redmond and Tankersley (2005)

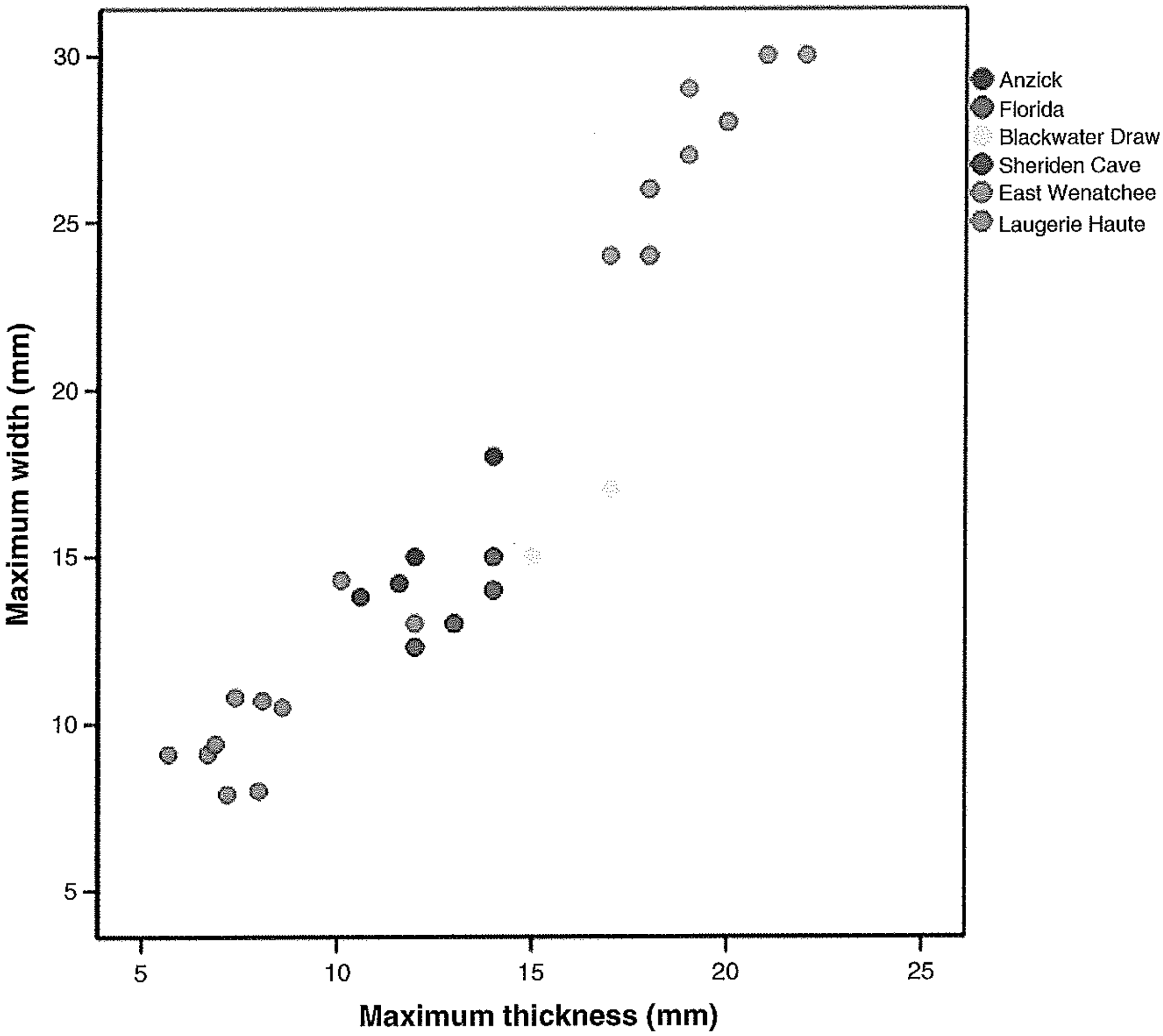

Fig. 15.6 (continued)

(e.g., Knecht 1991, 1993) in terms of manufacture: the use of bone over antler, longitudinal scraping of the shaft to form a tapered tip, scoring of the bevel with incisions, and the presence of striations on lateral margins and opposite the beveled surface (Redmond and Tankersley 2005).

One of the more interesting examples of a Paleoindian bone projectile point is a specimen found embedded in a rib of a single disarticulated mastodon at the Manis site on the Olympic Peninsula of western Washington. Excavations in 1977–1979 at the base of a kettle pond unearthed mastodon bones that showed evidence of spiral fracturing and cut marks (Gustafson et al. 1979; Gilbow 1981; Petersen et al. 1983; Gustafson 1985). Two little-known bone specimens displayed evidence of what was interpreted as use-related "polish" (Runnings et al. 1989). The single best-known artifact found associated with the mastodon was a foreign bone fragment, interpreted as the tip of a bone or antler projectile point, embedded in a mastodon rib (Gustafson et al. 1979; Waters et al. 2011). Radiocarbon ages of around 14,000 cal BP were obtained from organic matter associated with the mastodon, putting it earlier than Clovis (Gustafson 1985). Confidence in both the age of and evidence for human involvement with the Manis mastodon waned rapidly in the years following discovery (e.g., Grayson and Meltzer 2002; Haynes 2002); Dincauze (1984), for example, does not mention Manis in her overview of evidence for pre-Clovis archaeological materials in the western hemisphere. Subsequent AMS radiocarbon dating by Waters et al. (2011)

showed that the age of the mastodon was between 13,860 and 13,765 cal BP, still earlier than Clovis.

In addition, high-resolution X-ray computed tomography (CT) scanning revealed that the osseous object embedded in the rib was dense bone shaped to a point. Waters et al. (2011:352) note that "the point would have penetrated the hair and skin and about 25 to 30 cm of superficial epaxial muscles. … Thus it was at least 27 to 32 cm long, comparable with the known length of later, Clovis-age thrown and thrust bone points." Perhaps, but if the dimensions are correct, the Manis point was considerably longer than the points from Sheriden Cave (Redmond and Tankersley 2005). Waters and colleagues found no evidence of bone growth around the point, indicating that the mastodon died soon after the point entered it. Questions remain, however, as to whether the foreign object embedded in the rib is in fact a projectile point (Largent 2012).

Pressure-Flaker Handles

Wilke et al. (1991:258) suggest on the basis of ethnographic documentation that the rods from Anzick "represent a type of hand-held tool that once had an additional part attached to the beveled end with pitch and sinew. Such an implement would be a pressure flaker, with an antler bit bound to the beveled end or ends of a bone or ivory handle." Experiments they performed indicated that "pitch was necessary to keep the bit from slipping on the bevel, and incisions on the lateral and dorsal surfaces of the beveled ends of the handles were necessary to keep the sinew from slipping toward the [distal] end" (p. 259). Lahren and Bonnichsen (1974:149) state that "black material, probably resin, is still apparent on the beveled ends of six of the seven specimens." Damage on one end of one of the Anzick rods is thought to have been produced when the bit wore down and was not rehafted to extend beyond the end of the handle. Wilke et al. (1991:266) state that all rod specimens from Anzick are broken and note that the reason(s) for this "cannot be determined."

Sled-Runner Shoes

Gramly (1993) believes that the beveled bone rods from East Wenatchee were used as "sled shoes"—coverings for sled runners. Those specimens, however, are nothing like archaeological specimens of what have been called bone and ivory sled shoes associated with the Western Thule culture (ca. 1000 BP) of Alaska (Giddings and Anderson 1986) or with the Dorset culture (ca. 2500–1000 BP) of the eastern Arctic (Maxwell 1985). This is not to say that Paleoindian sled shoes had to resemble those made nine or ten millennia later; rather, the point is that those later archaeological specimens are not morphologically similar to the East Wenatchee bone rods. The Arctic specimens have wide, thin cross sections, relatively flat surfaces, and perforations that apparently were used in lashing the shoes to sled runners. If the East Wenatchee specimens had been so used, one would expect use-wear in the form of striae parallel to the long axis of the rods and distributed on only one face of each rod, but Gramly (1993) does not report evidence of this sort of wear. No evidence of such wear shows up on the precise replicas made by Peter Bostrum of the Lithic Casting Lab.

Wedges/Prybars

That rods of one sort or another were used prehistorically to butcher carcasses is indicated by some of the butchering marks on remains of late Pleistocene proboscidians in North American sites (e.g., Fisher, 1984a, b; Shipman et al. 1984; Fisher et al. 1994). Based on an analysis of mammoth remains from Blackwater Draw that were associated with two bi-beveled rods, Saunders and Daeschler (1994) proposed that the rods acted as wedges to dismember at least the feet of the animals. They made this proposal based on indentations observed on the foot bones of two mammoths that matched the dimensions of the rods. Experimental evidence supports the usefulness of bone rods during dismemberment (Park 1978). Reports on ethnoarchaeological research among modern African foragers who still hunt proboscidians do not mention the use of wedges or prybars to assist with butchering the carcass (Crader 1983; Fisher 1992), but the hunters employ metal tools, including hatchets and machetes, which may negate the necessity of a prybar to help hold joints apart for dissection with a stone knife.

Staffs

Bradley (1995) proposed that bi-beveled rods were placed bevel to bevel to form meter-long staffs that held some symbolic function—a proposal based on the fact that rods have been found in association with ochre-covered artifacts and skeletal remains, such as those from Anzick (Lahren and Bonnichsen 1974). We do not see much utility in this speculative scenario. As we noted with respect to the hypothesis of a lengthy foreshaft made of multiple bi-beveled rods, the bevel angles would have to be identical to create a straight staff. If the staff were, say, about 1 m long, then using the East Wenatchee specimens, which average about 20 cm in length, four bevel-to-bevel joints between five specimens would be required. A longer staff would require more joints. The sturdiness of such a composite tool is unknown.

Spears

Painter (1986) proposed that bi-beveled rods were midsections of broken tools that were then beveled and lashed together and finally outfitted with a pointed bone at the distal end and a blunted bone at the proximal end to create a composite spear. One problem with this proposition is that if bevels are the locations of repair, we would not expect a pair of bevels on one rod to always be located on the same side of the rod (Pearson 1999).

Hafting Wedges

Based on several lines of evidence—technological, contextual, and experimental—Lyman et al. (1998) proposed that some bi-beveled rods served a primary function as levered hafting wedges used to tighten sinew binding on saw-like Clovis implements. Their analysis centered on the 14 bone bi-beveled rods and 14 large Clovis points from East Wenatchee (Fig. 15.2). In their model, a wooden handle was nocked, a groove was cut in the handle to accommodate a bi-beveled rod, and a large Clovis-style biface was placed in the nock and wrapped with sinew. The groove for the rod extended onto one tang of the nock, and the rod was slid into the groove and levered down to tighten the overwrapped sinew. This leverage helped retighten the sinew as it became moist and stretched during butchering and precluded the necessity of unwrapping, remounting, and rewrapping to tighten the haft. Grooves cut on the bevels of the rod helped hold it in place when it is levered down. Lyman and colleagues proposed that the hafting-wedge function of the rods readily accounts for why they were beveled on both ends. Should the beveled end being used as a binding wedge fracture, one has but to merely turn the rod 180°, insert the intact edge under the haft binding, and lever the rod down to maintain a tight binding. The fact that 15 of the 18 preserved beveled ends of the East Wenatchee specimens display fractures across the bevel precisely like an experimentally broken hafting wedge lends strength to this interpretation of the East Wenatchee rods. Beveling of the proximal end—toward the handle—allows the binding holding it down to be more easily slipped on and off the levered-down end of the rod. The thick cross section of the East Wenatchee rods would have made for a larger cross section under the bevel, where the most force was concentrated when the rod was being used to tighten the haft binding.

One stimulus to the experimental work by Lyman and colleagues (Lyman et al. 1998; Lyman and O'Brien 1999) was the recovery context of many of the bi-beveled bone rods—caches containing large bifaces, fluted bifaces, and occasionally other items (Kilby 2008). These include Anzick (Jones and Bonnichsen 1994), East Wenatchee (Mehringer 1988a, b, 1989; Gramly 1993), and probably Drake, in northeastern Colorado (Stanford and Jodry 1988). It was the fact that 14 rods and 14 Clovis points—one rod per point—were found at East Wenatchee that prompted Lyman and colleagues to wonder if that correspondence might be significant. Incidentally, if Lassen (2005) is correct in his assessment of the number of rods represented among the pieces from Anzick—eight—then there are now two caches that contain equal numbers of rods and Clovis points.

Discussion

As Lyman et al. (1998:904) point out, "the archaeological record of Clovis-era rods is not what one might hope for." Of the specimens listed in Table 15.1, which represent only a small fraction of the number of specimens that have been found in North America, fewer than half were recovered from well-reported primary contexts. For example, it is unclear as to the precise nature of the recovery contexts of many of the specimens from Florida, but based on our review of the literature (e.g., Dunbar and Waller 1983; Dunbar et al. 1989; Dunbar and Webb 1996; Hemmings 1999; Webb and Hemmings 2001), few were in primary contexts. Instead, they came from sinkholes, rivers, and beaches. Aquatic environments provide protection for ivory and bone artifacts much more than do other depositional regimes except perhaps for peat bogs, limestone-enriched sediments, rockshelters, and xeric settings (Pearson 1999).

Even in the rare instances where rods have been recovered from primary contexts, there often is a lack of consensus as to the nature of the context. For example, Gramly (1993) stated that the specimens from East Wenatchee were located in a shallow 1.1-by-1.5-m pit—a conclusion based on observations of slightly darker, looser sediment above the artifacts. Mierendorf (1997) disputes the claim. At Anzick, initial thinking was that the rods and lithic tools were burial offerings interred with the remains of two juveniles (Lahren and Bonnichsen 1974; Wilke et al. 1991). Lahren (1999) revised this account to include only one of the two individuals with the cache (see Lassen 2005). Chronological reassessment by Morrow and Fiedel (2006) and Stafford (Waters and Stafford 2007) suggests that the human remains postdate deposition of the Clovis cache (see Lahren 2006 for historical details on the site).

Another issue that has stymied the study of Paleoindian bone and ivory rods is inconsistency in how data have been reported (Lyman et al. 1998; Moore and Schmidt 2009). For example, there is minimal consistency in the specific attributes chosen to describe particular specimens, with the exception that it is typically, but not always, noted that a particular specimen is beveled on one or both ends, made of bone or ivory, and is long relative to width and thickness. As a result of the quality of the published record, it is unclear if, for example, variation in length and maximum width displayed by a sample of these specimens (Fig. 15.3) represents morphological variation that is somehow functionally significant. Further, inferring typological identity of specimens cannot be accomplished with any reliability because there is no agreed-on set of necessary and sufficient conditions for type membership. An additional stumbling block here is that minimal discussion has been offered as to the analytical purpose of the types. Are they for descriptive purposes, are they index fossils indicative of age or cultural affiliation, or are they meant to facilitate interpretation of the function(s) of the specimens? We suggest that what might be referred to as *principles of systematics* is where future studies of these fascinating items must begin (e.g., Lyman and O'Brien 2002; O'Brien and Lyman 2002).

Chronology is also problematic for bone and ivory technology in North America because with few exceptions, such as Sheriden Cave (Redmond and Tankersley 2005; Waters et al. 2009, 2011) and Anzick (Morrow and Fiedel 2006), temporal affiliation is based solely on (1) association with Clovis points, such as at East Wenatchee, or (2) morphological similarity with specimens from those associations, such as the Florida finds. We currently do not know if or how single- or bi-beveled rods changed over time in terms of function or when they dropped out of use.

Based on what we *do* know about beveled rods, it appears that, as Taylor (2006) listed them, the following characteristics generally apply. The rods are:

- made from mammoth bone or ivory
- 150–250 mm long
- 10–30 mm wide
- 10–22 mm thick
- beveled on one or both ends
- scored on the beveled surface with cross hatching
- found with Clovis points and bifaces in cache and kill sites

With very few exceptions, these characteristics line up well with those specimens listed in Table 15.1.

If form and function are related, it appears that bone and ivory rods served a variety of purposes. Our best guess, backed up by experimental data, is that single-bevel pieces served as projectile points—certainly the evidence from one of the specimens from Sheriden Cave (Redmond and Tankersley 2005) indicates as much—whereas bi-beveled rods could have served as foreshafts and perhaps as hafting wedges. Certainly any piece at any time could have been multipurpose, including serving as a prybar, as Saunders and Daeschler (1994) propose for the specimens from Blackwater Draw. As more specimens are described, with an eye to the kind of detail that Redmond and Tankersley (2005; Waters et al. 2009) noted for the specimens from Sheriden Cave, our knowledge of how Paleoindian osseous rods were made and used should increase considerably. We echo a point made by Moore and Schmidt (2009:57): Given appropriate attention to such things as microtraces of manufacturing and use-wear, "organic implements can provide a more than adequate means of developing and testing hypotheses concerning prehistoric technological organization, social interaction, and settlement distributions."

Note Radiocarbon dates discussed here appear in the literature in various forms, but irrespective of whether a date was reported in raw radiocarbon years, as a calibrated date, or both, we (re)calibrated all dates using CalPal ver.1.5 (http://www.calpal-online.de) to create uniformity.

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