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Technical aspects of a worked proboscidean tusk from Inmachuk River, Seward Peninsula, Alaska

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Abstract

Prehistoric reduction sequences of proboscidean ivory have been described and discussed within the Russian and European Upper Paleolithic archaeological literature. A culturally modified proboscidean tusk (*Mammuthus* sp.) in Seward Peninsula, northwestern Alaska, displays longitudinal grooving, providing an insight into a reduction technique rarely described within North American archaeological literature. Similar reduction sequences have been described for the production of bone, antler and walrus ivory artifacts in the North American prehistoric record; however, examples on proboscidean ivory are extremely rare.

Keywords: Proboscidean ivory reduction technology; Grooving techniques; Northwest Alaska

1. Introduction

This article describes a culturally modified proboscidean tusk (*Mammuthus* sp.) found along the Inmachuk River near the Native village of Deering, just east of the Bering Land Bridge National Preserve on the Seward Peninsula, northwestern Alaska. The tusk surface exhibits extensive longitudinal grooving and provides evidence of a technique used in an ivory reduction sequence. While examples of similar reduction techniques on bone, antler, and walrus ivory are relatively common in arctic cultures, an example of this technique on mammoth or mastodon ivory has seldom been described outside of the Russian or European Upper Paleolithic, and is therefore rare in North America.

The tusk is radiocarbon dated to around 35,000 BP (uncalibrated years before present). Examination of the tusk reveals that each of several grooves have numerous parallel striations indicating the repetitive use of narrow, sharp-edged tools of stone or metal (as opposed to the marks left by modern tools, i.e., squared grooves created with a saw blade or distinct textures created by grinding discs). Since stone burins were used over a long span of prehistory, conclusive dating of this activity on the tusk may be difficult. Based on discussions in the literature, it is unclear as to whether experiments or observations have determined significant differences between metal and stone burin effects on ivory [5].

Tusk structure is responsible for basic limitations on ivory reduction; curvature, size, density and integrity, i.e., the amount of desiccation or deterioration of the collagen between Schreger lines [5]. Ethnographers describe several methods of treating ivory to change its consistency and increase the workability of this relatively hard material. One researcher notes that the ‘‘initial splitting is the most difficult part of the process’’ and it is this ‘‘complexity of initial splitting techniques that makes it worthwhile to examine this part of tusk processing as a special technology’’ [19].

2. Background

Much of the information on prehistoric ivory reduction techniques is based on material assemblages from Central Russian Plain sites such as Avdeevo, Kostenki 1, Eliseevichi 1,

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and Yudinovo; the Moravian site of Dolni Vestonici; and the Siberian sites near Lake Baikal such as Mal'ta and Buret' [1,37]. From literature describing these sites, it is evident that the grooving technique employed in the reduction sequence similar to that illustrated by the Inmachuk River tusk has been a basic method of tusk reduction for millennia. In North America, studies on mammoth bone rather than ivory reduction are more common, with substantial data generated from the Yukon Territory to western Alaska [16,26].

One of the earliest detailed descriptions of ivory reduction sequences was written by Semenov in *Prehistoric Technology* [34]. He illustrates the conceptualized sequence: repeated scoring with hafted stone burins along the length of a tusk, in several parallel locations, resulting in longitudinal grooves of various depths followed by the use of wedges (possibly antler) positioned in these grooves, which are hammered until the length of tusk between the parallel grooves breaks away. A description of flake removal from tusks by percussion is also illustrated, and a transverse severance (cross-grain) method of reduction by multiple chopped grooves is also described [34]. The tusk artifacts illustrated by Semenov come from the Russian sites of Eliseevich, Timinovka and Mal'ta, and had as many as 10 parallel grooves at 1.5–2 cm intervals, which potentially yielded 10 lengths of ivory. More recently, Khlopatchev [18,19] has examined ivory artifacts from Avdeevo, Kostenki 1 and 4, Timonovka, Yudinovo and Suponevo, and determined that tusk processing may have been more complex than previously thought, employing carefully controlled grooving and knapping techniques to create either flat or rod shaped pieces, with little use of cutting or chopping.

In North America, artifact assemblages occasionally include proboscidean ivory rods or batons, though more often these artifacts are made of bone. Rods have been recovered mainly at sites in the West (Alaska, Arizona, Montana, New Mexico, Oregon, Washington, and Wyoming) [3,8,20,24,25,27,29,30]. Many are associated with Clovis sites; several sites as easterly as Florida have assemblages with ivory rods [11]. The morphology of the rods is consistent (lengths are at least 20 cm and diameters are 1–2 cm), with polished shafts and bevels or flats worked onto a portion of one or both ends. Rods are noted here because of the possibility of grooving as a means of their production.

In the region in which the Inmachuk tusk was found, proboscidean ivory has been found in association with archaeological sites occupied during late Holocene throughout the late prehistoric and protohistoric periods [9,10,22]. No sites older than first millennium AD have thus far been identified in the immediate vicinity of the tusk find, although a potential Late Pleistocene component at Trail Creek Caves [21] lies about 50 km to the south of the find area. However, interior Alaskan sites of deeper time depth do include ivory fragments and rods of proboscidean ivory similar to rods elsewhere on the continent. These finds indicate that during the central Alaskan Pleistocene–Holocene transition, cultural groups utilized both fresh and curated mammoth ivory [12–14,30,31]. Though we know of no example of ivory reduction similar to the Inmachuk tusk in other Alaskan collections, such a specimen may exist in private or other collections that have left Alaska, and is perhaps unrecognized.

3. Context and setting

3.1. Location of the tusk

The tusk was found in the Inmachuk River drainage, located upstream from the Native village of Deering, located on the northern shore of the Seward Peninsula, northwest Alaska (Figs. 1 and 2). Thick deposits of Quaternary age alluvium fill the Inmachuk River valley; well logs from the Deering spit reveal unconsolidated sediments extending to 90 ft below surface [32]. The area was not glaciated during Wisconsinan glaciation.

The tusk was first reported to Peter Bowers by Deering resident Brian Weinart in 2002, although an opportunity to examine the location of the find did not occur until two years later. The find location (on private land) is part of an active gravel pit along the Inmachuk River within a point bar deposit. The tusk reportedly was found beneath a prominent heavily oxidized sand–gravel layer, in a swale about 2 m deep and 5 m wide. We examined a 2.5-m high cut bank on the opposite side of the river from the discovery site and noted the oxidized zone (dark red color; 2.5 YR 3/4) similar to that which had been overlying the tusk. The zone is 20–40 cm in thickness, beginning about 1.5 m below surface, and can be observed for several kilometer up and downstream from the site, suggesting a widespread ponding of this part of the Inmachuk River in the past. Because the site is part of a point bar deposit, it can be assumed that the tusk has been moved over time. The swale context and locally widespread oxidized layer implies a marsh or pond environment, which may explain why the specimen is well preserved.

3.2. Age of the tusk

Though the age of the tusk is only peripherally relevant to the significance of the reduction described in this paper, the tusk was sampled for dating. A single bone collagen sample from the tusk was dated by Beta Analytic, Inc. following standard pretreatment and analytical procedures. A 5.2 g of sample was first removed from an inner area, well beneath a surficial treatment of Elmer's Glue-ALL™, which the tusk's discoverer had initially applied to the surface. The resultant AMS date was 35,150 ± 530 BP (Beta-189092). Stable isotope ratios for $^{13}C/^{12}C$ and $^{15}N/^{14}N$ were −25.1‰ and +9.2‰, respectively. The latest mammoth remains in mainland Alaska are dated to around 11,400 BP [12,13]. Since the age of this tusk places it beyond the range of initial human habitation in the New World, as currently understood, we posit that the tusk was worked by later inhabitants of the area.

4. Tusk morphology and description

4.1. Overall description

The tusk is incomplete; the proximal (root) and distal (tip) ends are unevenly broken. No evidence of cutting or chopping

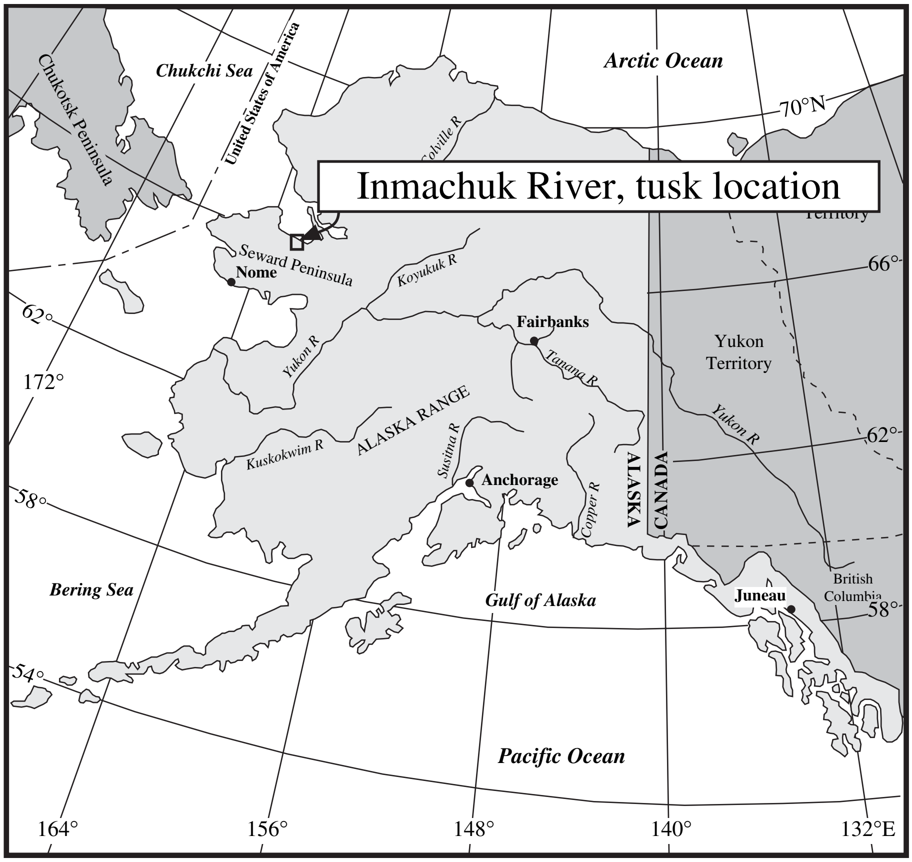

Fig. 1. Tusk location.

is exhibited at each broken end. The tusk is approximately 142.5 cm in length along the outside curve, and 131.5 cm along the inside curve. The diameter of the tusk is approximately 6–7 cm near the proximal end, and 8–9 cm mid-length near the distal end. The coloration of the ivory is dark brown on the exterior and becomes progressively lighter into the interior.

For identification of the Inmachuk tusk to species, known values of Schreger Pattern angles that are micromorphologically distinct to taxa [5], were compared from data compiled by Fisher et al. [6] and Trapani and Fisher [36]. Schreger Pattern angles on the Inmachuk River tusk average less than 100°, which is consistent with mammoth (*Mammuthus* sp.) tusk measurements [6,36].

Fig. 2. Inmachuk River tusk, top view (total length = 142.5 cm) [photograph by Brian Allen].

4.2. Description of the modified area of the tusk

On the inner curvature of the tusk, the cortex (exterior layer of dentin) and inner portions of the tusk are missing (approximately 50% of the whole), with the core and "bottoms" of at least three grooves clearly visible. The cortex remains on the outer curvature of the full length of the tusk piece. The modification consists of at least three faces resulting from removal of lengthwise pieces of ivory by deep, parallel grooves. Grooves are cut into the ivory from the surface toward the core and run lengthwise (in cross-section, the tusk would appear cut like a pie; see Fig. 3; Cross-sections A and B).

Measurements of the grooves (except part of groove 1; see below) are based on the one remaining side or face of each groove (i.e., what remains of the groove on the tusk core). Groove 1 extends from near the distal end of the tusk piece, including the intact piece and the continuing groove, to near the proximal end of the tusk piece: 117.0 cm in length, 1.8–2.4 cm in depth (width of face). Groove 2 extends from near the proximal end of the tusk piece to the mid-tusk area: 67.0 cm in length, 1.0–1.6 cm in depth (width of face). Groove 3 extends from near the proximal end of the tusk piece to the mid-tusk area: 84.6 cm in length, 1.7–2.2 cm in depth (width of face).

Part of groove 1 undercuts an intact length of tusk, providing the groove width; the groove is 44 cm in length with a depth of up to 2.0 cm, and width of 0.2–0.3 cm; the intact

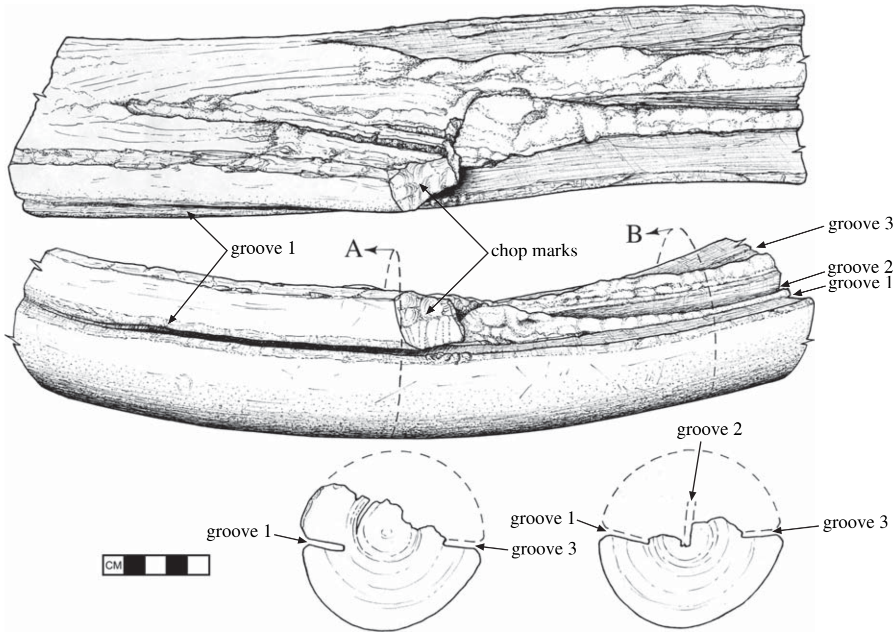

Fig. 3. Inmachuk River tusk top and side views and cross-sections [drawings by Carol Gelvin-Reymiller].

piece is terminated by multiple chop marks, but the groove itself continues. The chop marks appear to have facilitated the removal of an adjacent length of tusk, one that had been undercut by the same groove as the intact piece. Based on the intact length of ivory, the removed length would have been approximately 70 cm in length, 1.8–2.5 cm in width and depth, and shaped somewhat irregularly, like a piece of pie with the point removed; it is not evident whether the piece was removed in one length or several.

The bottoms of the grooves measure an average of approximately 0.3 cm in width, with some exhibiting two or more groove bottoms, as if the tool used to create the grooves was shifted in position slightly as work progressed. Bottoms are nearly flat or very slightly concave, and lines are not perfectly straight. Top margins of grooves exhibit faceting, approximately 0.5 cm in width, a result of the initial shallow scoring of the cortex to begin the grooving process, as is shown at one end of the intact piece (see Fig. 3, groove 1).

5. Brief summary of other Northern Alaskan worked tusk specimens

To understand this tusk in the context of Alaskan archaeology, the University of Alaska Museum of the North (UAM) Department of Archaeology collections were searched for examples of artifacts made of proboscidean ivory. Several small pieces of proboscidean ivory delaminated from the tusk (commonly termed ‘‘bark’’) exhibit scoring indicative of the grooving reduction technique. In addition, we examined the UAM Department of Earth Sciences collection of proboscidean tusks to understand whole tusk morphology, but in the interest of brevity, observations are not included here.

5.1. Ivory artifacts

Catalogs in the UAM archaeology collection were searched for references to mammoth or mastodon ivory. Three proboscidean ivory artifacts exhibiting grooving were located (Table 1). This perusal of the collections was by no means exhaustive; the three artifacts listed below were collected by J. L. Giddings in the 1940s at Kotzebue Sound region sites (AD 100–1000) [9]. The first specimen (1-1947-776; Fig. 4) is ivory that appears at first glance to have been used as a cutting board, having numerous shallow striations, generally running in one direction. On closer examination, the piece has been shaped on all sides, either by grooving or chopping; on the cortical surface, which covers approximately 40% of one side of the piece, and just beyond the cortex are two grooves that join into one trough, approximately 0.5–1 cm in depth. The trough or groove profile is more or less v-shaped, with uneven sides and a roughness that gives the appearance of being gouged with a less than optimally sharp tool. The thickest end (3.5 cm) of the roughly rectangular-shaped piece has been steeply beveled and snapped. The thinner end (2 cm) with cortex intact has been unevenly

Table 1
Proboscidean ivory artifacts with examples of grooving from the archaeological collection of the UA Museum

Accession No.	UAM catalog description	Site	Length (cm)	Width (cm)	Thickness (cm)
1-1947-776	Cutting board, mammoth ivory	Kotzebue House 8	8.5	6.5	2–3.5
1-1947-692	Large concave, piece, worked	Kotzebue House 11	42.8	7.8	1
1-1941-1040	Mammoth tusk, ivory, fragment	Tigara D 38	22.8	6.0	2.1–3

Fig. 4. Proboscidean ivory with grooving, UA Museum Acc. 1-1947-776.

broken. The inner surface of the piece has numerous shallow striations due to repeated slicing with a sharp-tipped implement, hence the "cutting board" label by Giddings. This inner surface shows chopped bevels along the lateral margins; the chops are perpendicular to the grain of the piece. Though the artifact undoubtedly was used as a cutting board on its inner surface, we believe that the groove on the cortex is the result of an ivory reduction sequence similar to that illustrated by the Inmachuk tusk. Its shallow depth indicates that it may have been the beginning or terminating end of a groove, or may represent an unfinished attempt at reduction by grooving. Later chopping action gave the piece its current flattened shape.

The second specimen (1-1947-692; Fig. 5) of ivory is a typical example of ivory bark, roughly rectangular in shape, a consistently thin (1 cm) layer of cortex retaining the curve of the tusk circumference. This piece has lateral margins that are worked or faceted, as from the beginning process of longitudinal grooving. At several intervals along the margins are marks in the ivory, possibly indicative of wedging. Both ends have been slightly beveled, and the surface exhibits slight exfoliation and pitting. Less can be said about this piece as illustration of ivory reduction, but the lateral edges look very similar to the uppermost faceted portion of grooves on the Inmachuk tusk.

The third specimen (1-1941-1040; Fig. 6) is also a piece of ivory bark, with grooving on the cortical face. The groove is approximately 7 cm in length and less than 0.5 cm deep at its end near the broken edge of the piece, and appears to be

Fig. 5. Proboscidean ivory with edge faceting, UA Museum Acc. 1-1947-692.

the beginning or termination of a deeper groove. Numerous shallow grooves on one lateral edge run parallel to the grain, and there is nicking perpendicular to the grain of the ivory. The inner face of the piece is unevenly broken. This piece is more degraded than the other two pieces, and surface details may have been lost.

The UAM collections include a number of excellent examples of the grooving technique on walrus ivory, caribou antler

Fig. 6. Proboscidean ivory with grooves, UA Museum Acc. 1-1941-1040.

and bone. Walrus ivory is distinguished from proboscidean ivory by a difference in color and cross-section, and by a marbleized core that is not present in proboscidean ivory; grooving walrus ivory appears similar in technique to proboscidean ivory but structure, especially the core, and size differ. Grooving in antler also differs in that the inner core is spongy and much softer than ivory. A reduction sequence for antler has been described by Corbin [4]. Bone likewise has a different structure than ivory (variable morphology, some with hollow marrow cavities). Notable is the size difference of potential objects created from materials other than proboscidean ivory, though walrus tusks reach lengths of over 50 cm.

6. Discussion

In general archaeological material classification schemes, ivory is not separated out as a material class but is included with bone, even though its properties are significantly different [7,28,33]. Much of the literature describing ivory artifacts borrows terms from lithic reduction. For example, Bonnichsen [2] described a bidirectional core of proboscidean ivory with platforms, negative scars, step fractures, etc. Khlopatchev [19] observes that ''tusk knapping [studies are] less evolved than flint knapping studies,'' and uses the terms core, platform and negative scars consistent with usage in lithic description. Khlopatchev also states that the two knapping technologies differ in four significant aspects: (1) the internal structure of the tusk is governed by growth reflected in Schreger lines; (2) flaking can be done either by exploiting cracks in the surface of the cortex, or by breaking with two blows performed simultaneously and from different directions creating a deeply penetrating crack; (3) the tusk's natural shape is utilized and corrected rather than totally transformed. Significantly, correction is ''attained through making cracks or grooves on tusk exterior surface[s]. The form of the groove and its orientation were intentionally produced'' and ''grooves functioned as a sort of striking platform on the curved surface of the tusk''; and (4) two definite geometrical shapes (rod or flat) are consistently the results of ''tusk knapping.'' Khlopatchev describes a grooving technique similar to that of Semenov, but seems to suggest that percussion rather than wedges plays a larger part in the reduction sequence.

The measures of the removed lengths of ivory from the Inmachuk tusk, roughly 1.5–2 cm^2 before smoothing or shaping and of undetermined length (possibly well over 20 cm) fit within average measures of known rods or batons. If further experimental comparative studies on the diagnostic traits left by burin tooling were performed, we may be able to say definitively whether stone or metal created the grooves in the Inmachuk tusk. However, lithic tools were used very late in Kotzebue Sound and other areas of the arctic, and thus would only give us a broad timeframe for when the tusk was worked.

The state of the ivory, whether green or sub-fossil at the time the tusk was worked, may be an indicator for timeframe. Some experiments reveal that soaking ivory in water allows for much easier shaping or gouging of the material [38]. This could result in conflation of ivory worked green and ivory freshened by soaking. Jochelson [17] reported that the Koryak softened ivory with urine to facilitate its working. Others report that long frozen tusks from permafrost appear green or fresh [15]. Further experiments assessed at a microscopic level might prove useful.

The tusk that prompted this research is an excellent example of an ivory reduction sequence, which appears to have been a basic way of reducing proboscidean ivory to usable pieces for millennia. From a technical standpoint, the Inmachuk tusk is a valuable addition to existing examples (from Europe and Russia) of prehistoric methods of ivory reduction, and may be the only known example of its kind from North America. The UAM archaeological collections yielded some intriguing artifacts that possibly represent byproducts or ancillary examples of the ivory reduction technique of grooving on mammoth ivory. Other North American artifact assemblages indicate that American hunters did use ivory; can the lack of evidence of the reduction technique be attributed to the value placed on ivory (complete reduction of tusk into tools), to the difficulty in working ivory, as opposed to bone, antler or wood, or to differential preservation or lack of discovery? Decision making trees have been proposed for understanding prehistoric craftsmen's use of ivory, bone and antler [2], but it is admittedly difficult to identify the factors connected in the craftsman's mind, such as a cultural relationship to the nature of the animal from which the material is taken, the desirability of a material due to perceived rarity or other socially determined factors, or simply personal preferences based on the characteristics of the material or skill level of the craftsman [23,35]. However, the reduction processes for proboscidean ivory is presented here can inform us as to the basic technological parameters of this process.

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References

[1] Z.A. Abramova, G.V. Grigorieva, G.I. Zaitsev, The age of Upper Paleolithic sites in the Middle Dnieper River Basin of Eastern Europe, Radiocarbon 43 (2001) 1077–1084.

[2] R. Bonnichsen, Pleistocene bone technology Archeological Survey of Canada Paper #89, Ottawa, in: National Museum of Man Mercury Series (1979).
[3] B. Bradley, Clovis ivory and bone tools, in: J. Hahn, M. Menu, Y. Taborin, P. Walter, F. Widemann (Eds.), Le Travail et L'Usage de L'Ivoire au Paleolithique Superieur, Centro Universtario Europeo Per I Beni Culturali, Ravello, 1995.
[4] J.E. Corbin, Aniganigaruk: a study in Numamiut Eskimo archaeology, PhD thesis, Washington State University, 1975.
[5] E. Espinoza, M.-J. Mann, History and significance of the Schreger pattern in proboscidean ivory characterization, Journal of the American Institute for Conservation 32 (1993) 241–248.
[6] D.C. Fisher, J. Trapani, J. Shoshani, M. Woodford, The Schreger pattern in mastodon and mammoth tusk dentin, Current Research in the Pleistocene 15 (1998) 105–107.
[7] F. Fladerer, A calf-dominated mammoth age profile from the 27 ky BP stadial Krems-Wachtberg site in the middle Danube valley, in: J. Reumer, J. deVos, D. Mol (Eds.), Advances in Mammoth Research, Proceedings of the Second International Mammoth Conference, Deinsea, Annual of the Natural History Museum, Rotterdam, 2003, pp. 135–158.
[8] G.C. Frison, C. Craig, Bone, antler, and ivory artifacts and manufacture technology, in: G.C. Frison, D.J. Stanford (Eds.), The Agate Basin Site: A Record of the Paleoindian Occupation of the Northwestern High Plains, Academic Press, New York, 1982, pp. 161–173.
[9] J.L. Giddings Jr., The Arctic Woodland Culture, Museum Monographs, University Museum, University of Pennsylvania, Philadelphia, 1952.
[10] J.L. Giddings Jr., The Archaeology of Cape Denbigh, Brown University Press, Providence, 1964.
[11] C.A. Hemmings, The organic clovis: a single continent-wide cultural adaptation, PhD dissertation, Department of Anthropology, University of Florida, Gainesville, 2004.
[12] C.E. Holmes, Broken mammoth, in: F. West (Ed.), American Beginnings: The Prehistory and Paleoecology of Beringia, University of Chicago Press, Chicago and London, 1996, pp. 312–318.
[13] C.E. Holmes, Tanana River valley archaeology circa 14,000 to 9000 BP, Arctic Anthropology 38 (2001) 154–170.
[14] C.E. Holmes, R. VanderHoek, T. Dilley, Swan point, in: F.H. West (Ed.), American Beginnings: The Prehistory and Paleoecology of Beringia, University of Chicago Press, Chicago and London, 1996, pp. 319–323.
[15] F. Holt-Wheeler, The Tusk-Hunters, Lothrop, Lee and Shepard Co., Boston, 1927.
[16] W.N. Irving, A.V. Jopling, I. Kritsch-Armstrong, Studies of bone technology and taphonomy, Old Crow Basin, Yukon Territory, in: R. Bonnichsen, M.H. Sorg (Eds.), Bone Modification, Peopling of the Americas Publications, Center for the Study of the First Americans, Institute for Quaternary Studies, University of Maine, 1989, pp. 347–379.
[17] W. Jochelson, The Koryak, The North Pacific Jesup Expedition, VI (1908) 647 pp.
[18] G.A. Khlopatchev, The morphological features of 4 ornamented blades of the churing group from the Upper Palaeolithic site Eliseevichi 1, in: Cultural Translations, State University of St. Petersburg 1994, pp. 157–159.
[19] G.A. Khlopatchev, Mammoth tusk processing using the knapping technique in the Upper Paleolithic of the Central Russian Plain, in: The World of Elephants – International Congress (2001), pp. 444–447 (Rome).
[20] L. Larhen, R. Bonnichsen, Bone foreshafts from a Clovis burial in Southwestern Montana, Science 186 (1974) 147–150.
[21] H. Larsen, Trail Creek: final report of excavations of two caves on Seward Peninsula, Alaska, Acta Arctica 15 (1968) Copenhagen.
[22] H. Larsen, F. Rainey, Ipiutak and the Arctic whale hunting culture, in: Anthropological Papers of the American Museum of Natural History, 42 (1948) New York.
[23] G.M. LeMoine, C.M. Darwent, The walrus and the carpenter: Late Dorset ivory working in the high arctic, Journal of Archaeological Science 25 (1998) 73–83.
[24] R.L. Lyman, M.J. O'Brien, V. Haynes, A mechanical and functional study of bone rods from the Richey-Roberts Clovis cache, Washington, U.S.A. Journal of Archaeological Science 25 (1998) 887–907.
[25] R.L. Lyman, M.J. O'Brien, Prehistoric osseous rods from North America: arguments on function, North American Archaeologist 20 (1999) 347–364.
[26] R.E. Morlan, Pleistocene archaeology in Old Crow Basin: a critical reappraisal, in: A.L. Bryan (Ed.), New Evidence for the Pleistocene Peopling of the Americas, Center for the Study of Early Man, University of Maine, 1986, pp. 27–48.
[27] F. Painter, Pointed Weapons of Wood, Bone and Ivory: Survival Tools of Early Man in North America (Virginia, Norfolk) (2002), <www.csaci.org>.
[28] S. Pean, M. Patou-Mathis, Taphonomy of mammoth sites, in: J. Reumer, J. deVos, D. Mol (Eds.), Advances in Mammoth Research, Proceedings of the Second International Mammoth Conference, Deinsea, Annual of the Natural History Museum, Rotterdam, 2003, pp. 331–345.
[29] G.A. Pearson, North American Paleoindian bi-beveled bone and ivory rods: a new interpretation, North American Archaeologist 20 (1999) 81–103.
[30] B.A. Potter, Recent investigations at the Gerstle River site, a multicomponent site in central Alaska, Current Research in the Pleistocene 18 (2001) 52–54.
[31] B.A. Potter, Site structure and organization in central Alaska: archaeological investigations at Gerstle River, PhD dissertation, Department of Anthropology, University of Alaska Fairbanks, Fairbanks, 2005.
[32] R.E. Reanier, G.W. Sheehan, A.M. Jensen, Report of 1997 field discoveries, City of Deering Village Safe Water Cultural Resources Project, Copy of file at Northern Land Use Research, Inc., Fairbanks, Alaska, 1998.
[33] K. Scott, Mammoth bones modified by humans: evidence from La Cotte De St. Brelade, Jersey, Channel Islands, in: R. Bonnichsen, M.H. Sorg (Eds.), Bone Modification, Peopling of the Americas Publications, Center for the Study of the First Americans, Institute for Quaternary Studies, University of Maine, 1989, pp. 335–346.
[34] S.A. Semenov, Prehistoric Technology: An Experimental Study of the Oldest Tools and Artifacts from Traces of Manufacture and Wear M.W. Thompson, (Trans.), Harper Row Publishers, Great Britain, 1964.
[35] O. Soffer, Storage, sedentism and Eurasian Paleolithic record, Antiquity 63 (1989) 719–732.
[36] J. Trapani, D.C. Fisher, Discriminating proboscidean taxa using features of the Schreger pattern in tusk dentin, Journal of Archaeological Science 30 (2002) 429–438.
[37] S.A. Vasil'ev, Man and mammoth in Pleistocene Siberia, in: The World of Elephants – International Congress (2001), pp. 363–366 (Rome).
[38] R. White, Mammoth-Ivory as a raw material: structural and experimental perspectives, in: J. Hahn, M. Menu, Y. Taborin, P. Walter, F. Widemann (Eds.), Le Travail et L'Usage de L'Ivoire au Paleolithique Superieur, Centro Universitario Europeo Per I Beni Culturali, Ravello, 1995.