CRAFTING BONE – SKELETAL TECHNOLOGIES THROUGH TIME AND SPACE

Proceedings of the 2nd meeting of the (ICAZ) Worked Bone Research Group

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Introduction

Archaeologists and Archeozoologists, both study worked osseous materials (bone, antler and tooth, including ivory, in short all referred to as "bone"). Such reports, however, are often buried at the very back of faunal analyses appended to site reports. Furthermore, the two groups of specialists have had little chance to interact, even within Europe since they tend to attend different conferences and write for different fora.

At the root of this problem lay the arbitrary, largely institutional division between pre- and proto-historians, often imposed on bone manufacturing experts by nothing but formalism in research tradition. The most exemplary series of studies n this field is entitled: "*Industrie de l'os neolithique et de l'age de metaux*" (Bone industry *from the Neolithic and Metal Ages*). Another classic, a book, is sub-titled "The Technology of Skeletal Materials *since the Roman Period*". In very early prehistoric assemblages, attention is often focused on the question of whether a particular piece of bone was worked or not. In later assemblages, it is the intensity of manufacturing that often renders objects zoologically non-identifiable, so that important aspects of raw material procurement, including long distance trade, remain intangible.

The history of raw material use, however, is continuous and many of the constraints and possibilities inherent in skeletal materials are the same whether one is dealing with Paleolithic or Medieval artifacts. Indubitably, the organization of manufacture, the function and value of bone artifacts (as well as some technological innovations such as the regular use of metal tools or lathes), differ substantially between simple and complex societies through time. On the other hand, fundamental questions of tensile characteristics, procurement strategies, style and certain technological requirements are not only similar diachronically, but also open up new vistas when apparently unrelated periods are compared. The function of these objects as social markers, for example, remains remarkably constant through time, even if details vary. The papers in this volume reflect these conceptual similarities and differences as did the papers delivered at the conference itself.

The first meeting of what was to become the Worked Bone Research Group (WBRG) was organized by Dr. Ian Riddler in the **British Museum, London, in January 1997**. The committment and enthusiasm of that first workshop has greatly inspired subsequent efforts in recruiting a wide range of bone specialists, capable of contributing to discussions concerning bone manufacturing.

In keeping with the aims of the Worked Bone Research Group, since 2000 an official working group of the International Council for Archaeozoology (ICAZ), an effort was made to present these papers on the basis of what *connects* them rather than segregating them by archaeological period or region. Contributions mostly include articles based on papers delivered in September 1999 at the second Worked Bone Research Group meeting in Budapest, organized by the editors with the unfailing support of the Aquincum Museum (Budapest) and its staff. Several people who were unable to be present at this conference were also asked to contribute papers. Finally, five of the studies in this volume, originally delivered at a symposium on bone tools organized by Dr. Kitty Emery and Dr. Tom Wake, entitled "*Technology of Skeletal Materials: Considerations of Production, Method and Scale*", at the 64th Annual Meeting of the Society for American Archaeology (Chicago 1999), were added thereby expanding the academic spectrum both in terms of research tradition and geographic scope.

There are a total of 36 papers in this volume. Research was carried out on materials from Central and North America to various regions of Europe and Southwest Asia. The authors represent scientific traditons from Estonia, Hungary, Romania, and Russia, European countries in which, until recently, ideas developed in relative isolation. Other European countries represented include Austria, Denmark, France, Germany, Great Britain, Greece, and Switzerland. Last but not least, the North American scholarly approach is also represented here.

Schools of thought may be said to be exemplified by what used to be Soviet research, well known for pioneering works on taphonomy, experimentation and traceology. Bone manufacturing was first brought to the attention of Western scholars by the publication in 1964 of the translation of S. A. Semenov's *Prehistoric Technology*, published originally in 1957. Scholars in France have also carried out decades of co-ordinated work on operational chains in the manufacturing process from the selection of raw materials to finished products, with special emphasis on prehistoric modified bone. An entire working group, “Unspecialized Bone Industries/Bone Modification”, is directed by Marylene Patou-Mathis. This working group itself is part of a larger research program on bone industry “*La Commission de Nomenclature sure l’Indistrie de l’Os Prëhistorique*” headed my Mme. H. Camps-Fabrer. Several specialists such as Jörg Schibler in Switzerland, have created laboratories where ground laying work has been carried out for years on worked osseous materials, especially from Swiss Neolithic Lake Dwellings and Roman Period sites. Language barriers have often prevented these important bodies of work from being as widely disseminated as they deserve. Arthur MacGregor in England, writing in English, has had a decisive influence on specialists working on more recent Roman and Medieval worked bone assemblages in Europe.

The work of all of these groups as well as certain individual scholars is well known within limited circles. Otherwise, however, the overwhelming experience of most researchers on worked bone have been feelings of isolation and alienation from most archaeological or archaeozoological work related, most importantly, to the absence of an international forum where their often specialized work can be presented and problems discussed.

In spite of the fact that there have been many practical obstacles to information flow between specialists in this field, there are really remarkable similarities of approach which should ultimately lead to the development of more compatible paradigms in research. Agreement on methodologies will have a positive feedback on communications, helping the field to grow and develop properly.

It seems that, at last, archaeologists and archaeozoologists and other specialists are talking to each other and sharing methodologicial points of view. One striking example of this can be seen in the the emphasis on raw materials studied in parallel to types found in the majority of papers in this volume. Previously studies often concentrated on typo-chronological questions, ignoring the questions of raw material morphology and availability. The series published by the *Centre National de la Recherche Scientifique*, edited by Mme. Henriette Camps-Fabrer in France is largely to be credited for beginning this new trend. It contains many papers concentrating on understanding manufacturing sequences and, indeed, from Europe to North America there are papers which explicitly deal with manufacturing sequences in individual assemblages.

There is also a consistent emphasis on experiment and manufacturing techniques present in much of the work in this volume. The related but fraught question of function continues to tantalize and frustrate most specialists. A number of articles attempt to apply techniques of hard science, such as scanning electron microscopy or light microscopy, together with experiment to get objective, “processual” answers to this important group of questions. Other researchers rely deductively on analogy, archaeological context, gross morphology, and textual sources as they try understanding how these objects were used.

When editing the volume, we tried to concentate on the underlying main concepts represented by each paper rather than grouping them diachronically or by geographical region. As a result, contributions follow a line from the theoretical through the problems of raw material selection, manufacturing techniques, experimental work, technical function and socio-cultural interpretations. Obviously many of these papers deal with several of these aspects simultaneously. Finally, analyses of assemblages are grouped to show the current state of general application of these principles as illustrated in papers in the rest of the volume. Reports on bone tool types will ultimately benefit from more unified typologies and also provide researchers with comparitive databases from regions beyond their own.

Finally, a word on the organization of papers in this volume. Although the editors have tried to group these papers by what they see as the main theoretical and methodological thrust of the authors it should be understood that most papers, to a greater or lesser extent, overlap between these artificial sub-titles. Happily, almost all these works include considerations of raw material exploitation, manufacturing and functional analyses and all make some attempt to consider the social context from which these artifacts emerged. It is exactly this cross-cutting of boundaries which allows us to hope that the study of worked osseous materials is well on the way to developing into a discipline in its own right.

In addition to the generous support given by our sponsors and technical editors for this volume, organizing the conference would not have been possible without the active help of numerous colleagues. Special thanks are due to Paula Zsidy, Director of the Aquincum Museum, Katalin Simán, archaeologist and two students from the Institute of Archaeological Sciences (ELTE, Budapest): László Daróczi-Szabó and András Markó. The Hotel Wien, Budapest and its efficient manager provided a comfortable setting for our discussions at a reasonable price. Last but not least, help with abstract translations by Cornelia Becker, Noelle Provenzano as well as Marjan Mashkour and Turit Wilroy should also be acknowledged here.

THE IMPORTANCE OF THONG-SMOOTHERS AT BOTAI, KAZAKHSTAN

Sandra L. Olsen

Abstract: Thong-smoothers made on horse mandibles from the Eneolithic site of Botai, Kazakhstan, are discussed in light of their contribution to the evidence for early horse domestication there. Ethnographic accounts of thong production and the roles of thong-smoothers facilitate understanding of these tools. Metric analysis and scanning electron microscopy of wear traces on the prehistoric tools help confirm their identity as thong-smoothers.

Keywords: thong-smoother, Botai, Kazakhstan, Eneolithic, horse domestication

Résumé: Les lissoirs de courroie faits sur mandibules de cheval, provenant du site Enéolithique de Botai (Kazakhstan), sont examinées du point de vue de leur contribution à la question de la domestication ancienne du cheval dans cette région. Les données ethnographiques sur la production de courroies et le rôle des lissoirs de courroie facilitent la compréhension de ces outils. L'analyse métrique et l'étude au microscope électronique des traces d'utilisation aident à confirmer l'identification de ces outils en tant que lissoirs de courroie.

Mots-clés: lissoirs de courroie, Botai, Kazakhstan, Enéolithique, domestication du cheval

Zusammenfassung: Riemenglätter, die man aus Pferdeunterkiefern im eneolithischen Fundplatz Botai/Kasachstan hergestellt hat, werden hinsichtlich ihrer Bedeutung in Bezug auf die frühe Domestikation des Pferdes in dieser Region diskutiert. Ethnographische Belege zur Riemenherstellung und zur Rolle der Riemenglätter sollen das Verständnis zu diesen Artefakten erleichtern. Metrische Analysen und die elektronenmikroskopische Untersuchung von Abriebspuren an den vorgeschichtlichen Artefakten unterstützen ihre Deutung.

Schlüsselworte: Riemenglätter, Botai, Kasachstan, Eneolithikum, Pferdedomestikation

Introduction

The importance of bone artifacts in reconstructing prehistoric lifeways has rarely been emphasized in the literature, although many examples could be cited. This paper illustrates a case in which a particular bone tool type provides significant supportive evidence for the early control, taming, or domestication of horses in the Eurasian steppe. Although these tools alone do not indicate the manipulation of this species, they are crucial to building a logical case. For a detailed description of the entire evidence for horse taming or domestication at Botai, Kazakhstan, see Olsen (1996 and 2001 in press).

Thongs performed a myriad of functions in prehistoric societies, including hafting tools to wooden handles, lashing furnishings and parts of dwellings together, sewing leather clothing and footwear, and making snowshoes. They also served as lines for harpoons. For horse-herders, however, thongs were, and are, particularly important. In addition to other functions, thongs are used as single strands or braided in multiples to make ropes, bridles, whips, riding crops, hobbles, and lassoes. The Mongols, Kazakhs, and other equestrians on the Eurasian steppe also use thongs in pole-snares for capturing horses. Once saddles and stirrups were invented, thongs also became critical components of this tackle.

Thong-smoothers are generally uncommon in the archaeological and ethnographic literature, although they may have been overlooked in many cases. There are a few reports of their use among the Plains Indians and Arctic peoples, but most prehistoric and pre-industrial societies found some method for performing their functions.

To understand the role of a thong-smoother, it is useful to consider how a thong is first prepared. If the craftsperson simply cuts straight strips from a hide, then the length or girth of the animal determines the length of the thong. There are many instances, however, when the thong needs to be considerably longer. By cutting a spiral from the hide, the ultimate length of the thong is controlled by the overall area of the whole hide and the width of the thong, but it can be extremely long. The bigger the hide and the narrower the strip, the longer the thong can be. After it is cut, the thong initially has a spiral shape, so it needs to be worked to straighten it out.

The thong-smoother can serve to straighten, stretch, de-hair, or soften (break) the thong, depending on when in the process of preparation the implement is employed. Regardless of the roles this tool plays, the motion is basically the same. The thong is run back and forth across a crisp (but not sharp) edge of a rigid tool. Bone or antler is often the material of choice for this tool because of the ease with which a smooth edge that does not cut the hide can be produced. Sometimes the rim of a hole in bone or antler is used instead of a straight edge (Jenness 1937), with the same effect. Paleolithic batons-de-commandement, in some cases, possess wear indicating possible use as thong-smoothers, although others were almost certainly employed as shaft-straighteners. Jenness (1937) describes the distinctions in the wear and edge morphology between these two tools, but it is possible to use the same tool for both functions. Thong-smoothers can take such a wide variety of forms that it is difficult to find common ground from one culture to the next for recognizing their gross morphology. This paper attempts to define the minimal characteristics of such implements so that they might be recognized more frequently where they occur. In general, any crisp, smooth edge of a notch or perforation on bone or antler will suffice. If it is distinct enough, the width of the notch can provide a guide to the maximum width of the thongs that could be efficiently worked with the tool. Perforations are more delimiting and therefore more informative regarding thong width. In truth, the tool's edge need not be confined within a notch or perforation, but this does reduce slippage when the reciprocal motion of the thong is rapid. The rarity of thong-smoothers in other cultures sometimes may be because bone beamers with broad, gently curving blades served a dual purpose: to work thongs as well as larger pieces of hide.

Ethnographic Accounts of Thong-making

Wilson (1924), Ewers (1958), and Jenness (1937) provide the best descriptions of the process of manufacturing rawhide thongs and how a thong-smoother functioned. Ewers (1958:111) recounts the steps by which a Blackfeet woman prepared thongs from bison rawhide:

In making rope a woman cut one long continuous strip from a green bull hide. Beginning at the outer edge, she cut a strip about four inches wide, working around the hide in a concentric circle. Then she cut a slit near one end of this strip and drove a lodge peg through the slit into the ground. She stretched the rope as tight as she could and drove another peg into the ground through a similar slit at the other end of the line. Later she pulled up one peg, stretching the strip farther, and pegged it down again. After the rawhide dried, she took it off her simple stretcher and began softening it by rubbing the inner (meat) side with a rock. Then she doubled the strip lengthwise, hair side out, and bit it to hold the crease. **She passed one end of the strip through the eye sockets of a buffalo skull and, standing with one foot on the skull to steady it, used both hands to saw the strip back and forth through the eye holes to rub off the hair and further soften the hide** [emphasis added].

Wilson (1924: 185-89) has a detailed description of a Hidatsa man making a thong lariat from a hide. Before the hide was dry, he cut it spirally into a long strip about four inches (10 cm) wide and of uniform width. A rawhide strip that was to be made into a lariat was typically 42-48 feet (13-14 m) long. After cutting the strip, he staked it out, fur side up, shaved the hair off with his knife, and greased the rawhide well. The next day, after it had dried out, he greased it again. Holding it over a fire allowed the grease to soak in. After that he passed the strip around a cottonwood tree and drew it back and forth against the rough bark. This would have acted in a way similar to the thong-smoother, but on a courser level. He then coiled the strip and struck the tree with it repeatedly to "break" it. Following this, he drew it back and forth under a rough stone on which he stood. The strip was then softened by folding it and biting it between his incisors at intervals of about one inch (2.5 cm). The next day, he attached the strip to the lead horse by making a noose at one end and slipping it over the horse's head. The horse was allowed to drag it around all day so that the other horses could step on it and stretch it to its final length. Lastly, he trimmed it to make it narrower and more uniform in width.

Because thong-smoothers are poorly known in the archaeological record, it is beneficial to describe both their manufacture and use at a site where they are extremely common: the eneolithic settlement of Botai, in north-central Kazakhstan. Botai is a village of at least 158 pithouses (Kislenko & Tatarintseva 1999), occupied between 3600-3100 B.C. (Levine 1999; Benecke and von den Driesch 2001 in press). The site is remarkable for its overwhelmingly specialized diet of horsemeat. Ninety-nine percent of the vast faunal assemblage was derived from horses. The preponderance of evidence is pointing to the control, taming, or domestication of some portion of the horse population, while wounds in a few bones indicate that some of the kills were wild individuals. The current theory is that some horses were ridden to hunt wild herds (Olsen 1996; 2001 in press).

Although a similar focus on horses has been noted at paleolithic sites like Solutré, France, (Olsen 1989; 1995), these are not large sedentary communities. Solutré has been interpreted as a kill site, where animals were driven into a cul-de-sac that formed a natural corral. The dominance of horses at that site is due to exploitation of bands as they passed through the valley during seasonal migrations year after year. At Botai, on the other hand, a substantial population resided in a permanent village on the open steppe (Olsen 1996, Kislenko & Tatarintseva 1999), probably through the winter. Without domestication of some of the horses, it is difficult to imagine a risky economy based almost completely on one hunted species. Being able to ride domestic horses and use them for pack animals to bring meat back home would have made it considerably easier to hunt wild horses some distance from the village.

The evidence for early horse domestication is admittedly circumstantial because no morphological change is known to occur until breeds begin to appear and the various functions of horses may cause their mortality patterns to differ from wild horses. However, the amassed data are relatively convincing evidence that some horses were under human control at Botai. A nearly complete fetal horse skeleton was found eroding out of a bank in the village. Age and sex profiles express a slight tendency for the culling of young males relative to young females. Adult males predominate, however, probably partly because of sacrificial rituals involving stallions. In the subsequent Bronze and Iron Ages of the Eurasian steppe, stallions were the preferred horse offerings. The preference for including stallions in human burials may derive from the advantage of riding a slightly larger, stronger, and more aggressive animal on hunts and into situations involving human conflict. This was certainly true in historic times. Remains of 14 horses were incorporated in an Eneolithic burial pit containing four humans at Botai (Rikushina & Zaibert 1984) and there are numerous examples of horse skulls in ritual deposits with or without dog remains (Olsen 2000 in press). Across the steppe, domestic animals, including horses, cattle, and sheep, were incorporated in kurgan burial chambers (Mallory 1981, Jones-Bley 1997) with the exception of aurochs horn cores and cervid antlers. One horse skull from Botai shows a circular depressed fracture typical of pole-axing, a means of dispatching commonly found on skulls in ritual deposits in the Bronze Age and more likely to have occurred with tame or domestic animals. Series of articulated vertebrae, as well as an abundance of cranial and foot elements argue for minimal Schlepp Effect. This suggests either that kills of domestic horses were made in or near the village or that packhorses were available to carry even low-utility body parts of wild horses back from distant hunting forays. Horse dung has been reported from house fills (French & Kousoulakou, 2001 in press). Although it could have been collected from wild herds, if it is found in abundance in future excavations, it may contribute to other circumstantial evidence for the proximity of herds. In addition, over 270 horse mandibles were made into thong-smoothers, tools that would have been very useful for producing equipment to capture, control, and ride horses.

The Botai Bone Artifact Assemblage

The well-preserved collection of bone artifacts from Botai numbers around 900 objects, mostly made on horse bones. These have all been analyzed by this author and will be published separately. The types include a wide range of tools for pottery manufacture, hide-working, and weaving, as well as weapons, ornaments, and finely incised proximal phalanges of horse, kulan, and saiga antelope. Thong-smoothers make up 30% of the bone artifact assemblage and are some of the most common tools in the entire collection of objects from Botai.

Manufacture of Thong-smoothers

The Botai thong-smoothers were made in the following manner. First, the left and right mandibles were broken at the diastema, near the mental foramen, to remove the anterior teeth and separate the two jaws. A mandible was then prepared by knocking out the cheek teeth (fig. 1a). In experiments, this often cracked the surrounding bone of the horizontal ramus and allowed it to be peeled away (fig. 1b). The teeth could then be pried or pulled out of their alveoli. Crushing and flaking of the occlusal surfaces of many lower cheek teeth, especially third molars, show that they were struck by a hammer to loosen them (fig. 2).

Some 34 metapodial tools (fig. 3) from Botai may have been used to remove cheek teeth from the mandibles. The cortical bone of horse metapodial diaphyses can be as much as 14 mm thick mid-shaft, so they make very sturdy implements. These expedient tools have simply had one articular end removed by breaking. The tool would first be used to jar the teeth loose by striking their occlusal surfaces with its dense shaft. This is reflected in distinctive patches of use wear caused by repeated hammering located about 4-8 cm down from one or both ends of the tool (fig. 4). The impact damage on the tools is not located in the right position for percussion flaking stone (Bruce Bradley, pers. comm.), because it is too far down the shaft. Following the hammering, the tip of the broken end of the tool could be employed to pry out any teeth that resisted removal. The tips show some compression polish (Arndt & Newcomer 1986), rounding, and longitudinal striations running up from the end (fig. 5). The combination of these wear patterns at the tip and on the shaft could be explained best by this activity.

After the teeth were knocked out, the remaining thin bone of the horizontal ramus was percussion flaked, perhaps with a hammerstone. The shapes of the thong-smoothers are highly variable, but there are two basic forms. The first retains a broad surface near the gonial angle consisting of much of the ascending ramus and the posterior part of the horizontal ramus. The expanded surface area on this type would have been useful for clenching the tool between the knees or feet securely during use. An unfinished tool (fig. 6). shows how this type was made in at least one case, using the groove-and-snap technique. The two intersecting grooves prepared the tool blank so that excess bone could be snapped off along them in a controlled manner. Since there is only one example made in this way, it was probably more typical to simply knap the final outline of the tool. The second type of thong-smoother was more likely to result from the imprecise manner in which the mandibles were normally struck with the hammer. This type is narrower and follows the contours of the posterior and inferior margins of the mandible, giving it a shape similar to a boomerang or sickle (fig. 7b). The length of the tooth roots may have influenced how much of the horizontal ramus broke away in the process, thus affecting the overall morphology of the tool. After the general shape was achieved, one of the notches resulting from knapping away part of the jaw was selected (fig. 7a, b). This notch was then either abraded or scraped with a stone tool to smooth its working edge (fig. 8).

Morphological Characteristics of the Botai Thong-smoothers

Seventy-nine thong-smoothers were complete enough to merit metric analysis. Of these, 20 retained the broad surface of the ascending ramus, whereas 43 were sickle-shaped, and 16 were too fragmentary to determine their overall morphology. The width of the notch and the length of the polished edge were measured on these tools whenever possible. The notch width was measured on 50 specimens with intact notches by spanning the opening of the notch with digital calipers. The average width was 4.3 cm, and the range of widths was 1.1-6.5 cm. The polished edge was measured on 46 specimens with a flexible tape that could curve along the bottom of the notch. The average length of polish was 2.4 cm and the range of lengths was 1.0-4.2 cm. Because the rawhide strips could move around during the reciprocal motion involved in the activity, it is expected that thongs could be considerably narrower than the notches and still create wear over a larger area. These metric data do indicate that the average width of thongs at this stage of manufacture was no more than 4.3 cm and may have actually been closer to 2.4 cm. The thongs initially cut from bison hides by the Hidatsa and Blackfeet were approximately 10 cm, but they were trimmed at the end of the manufacturing process.

Use Wear on Thong-Smoothers

A thong-smoother is most easily recognized by the combination of the morphology of its working edge and characteristics of its use wear. Two types of wear exist on these tools: polish and striations. The first consists of a medium to high gloss along the working edge of the notch that usually fans out onto the two contiguous flat surfaces on either side (fig. 8). This polish, where it occurs, obliterates most of the manufacturing traces caused by abrading or scraping the notch. The manufacturing marks are visible outside the range of the polish.

The scanning electron microscope makes it possible to see details of a polished surface not visible through an optical microscope because the tool's surface is not obscured by light reflection (Olsen 1988). This makes the SEM quite useful for viewing the second type of wear. Very fine striations in the region of the polish can be seen sweeping over the edge and down the surfaces (fig. 9). These extremely delicate marks are important indicators of the direction of motion of the material over the working edge. They demonstrate that a reciprocal motion was involved and also that the material was flexible enough to bend around the edge and touch both surfaces. The marks are not strictly transverse to the working edge, but are usually slightly diagonal. This is apparently because of the angle at which the tool was held. Whether the striations were caused by fine grit, the animal's hair, or the rigid rawhide itself is uncertain at present. A horse rib beamer used to scrape a raccoon hide experimentally showed virtually identical wear-polish along the edge coupled with fine sweeping striae (fig.10). The widths of the notches on the mandible tools from Botai indicate that the pieces of hide being worked had to be narrow strips or thongs.

Conclusions

The thong-smoothers from Botai are important for a number of reasons. They provide information about a perishable material that would otherwise not be recognizable in the archaeological record. Hide working might be predicted because of the level of eneolithic technology and the paucity of raw materials available to the Botai people. Also, particular cutmarks on horse bones from the site (Olsen 2001 in press) are indicative of skinning. Without thong-smoothers, however, the use of thongs specifically would not be demonstrated, even though their presence might be expected.

Secondly, as an important aside, the large number of thong-smoothers had an impact on certain aspects of the general faunal analysis and subsequent interpretations. The entire collection of the estimated 300,000 bone fragments has not been completely analyzed, but virtually all of the dentition was studied. The minimum number of individuals for thong-smoothers is greater than that for any of the teeth. The MNI for the most common tooth was 71, whereas the MNI for mandible thong-smoothers was 135. The taphonomic results of using bone as a raw material for artifact manufacture have often gone unappreciated. The large MNI obtained for modified horse mandibles at Botai demonstrates what a dramatic impact such exploitation of certain elements can have on the faunal assemblage. It illustrates how important it is for the zooarchaeologist to examine the bone artifact assemblage closely and incorporate information on the elements used as manufacturing raw material in his or her general interpretation of the faunal material.

The destruction of tooth rows in the manufacture of thong-smoothers has an enormous influence on the ability to reconstruct mortality patterns and sex ratios at Botai. Most of the horse teeth are isolated because they were knocked out when mandibles were made into tools. It can be quite difficult to distinguish between third and fourth premolars or first and second molars of horses. Age determination is much more secure if a whole tooth row is present. Also, if the diastema has been smashed, then it is hard to determine the sex of the individual based on the presence of canine teeth in males. Loose horse canines are not easily recovered unless sieving is performed, which was not the case for all but the most recent excavations at Botai. Even if stallions' canines are found, without intact anterior mandibles it is difficult to reconstruct the proportions of females and immature males (with tiny deciduous canines embedded in the mandible). The sex ratio that was produced for Botai showed that adult males outnumbered all other groups, but this is almost certainly a product of ritual behavior. Stallions were normally selected for ritual deposits in the Eurasian steppe. Because their heads were buried in ceremonial pits, they survived intact far better than immature males and all females. The skulls of other individuals that were not selected for ritual deposits were likely to have been utilized for other purposes, including making mandible thong-smoothers.

Finally, the role of thong-smoothers at Botai in the control of tame or domestic horses should be examined. It is recognized that thongs are multi-purpose materials, but the abundance of tools specifically designed for the manufacture of thongs indicates their importance at Botai. When this evidence is combined with the dominance of horses (99%) in the faunal assemblage, a connection between these two is not unreasonable. If all of the horses represented in the faunal assemblage at Botai were wild, then what would be the need for so many thongs? One purpose might be the use of harpoons for hunting horses. Thirteen harpoons have been recovered from Botai and four wounds probably made by harpoons have been found in horse and large bovid bones. Thongs may have been used for harpoon lines, but the number of thong-smoothers is 21 times that of the number of harpoons and one thong-smoother can produce many thongs. It is unlikely, therefore, that harpoons contributed in a major way to the demand for thongs at Botai. The regularity with which thongs are described in equestrian societies like the American Plains Indians lends support for the adaptation of an equestrian life-style at Botai. When this evidence is combined with a wide range of other data regarding horse exploitation, the frequency of thong-smoothers at Botai is quite logical. The tools described here provide just one example of how important bone artifacts are for reconstruction of prehistoric life-styles, especially when put together with other lines of evidence.

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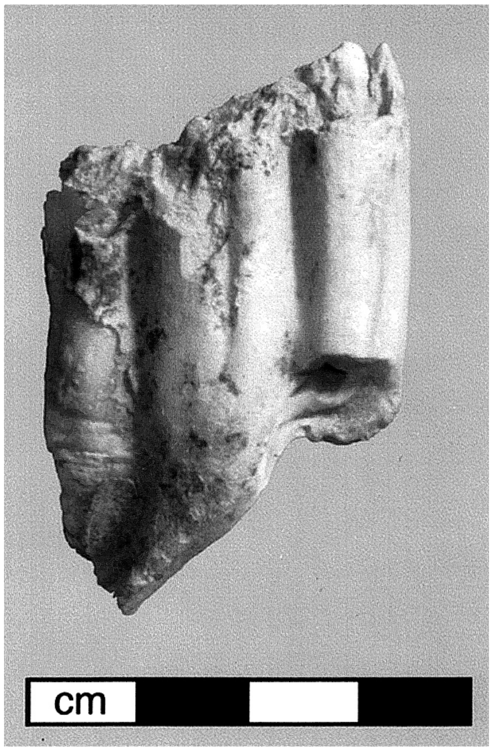

Fig. 2 Crushing and flaking on many lower cheek teeth show that they were struck by a hammer to loosen them

Fig. 1/A Hammering cheek teeth with horse metapodial
Fig. 1/B The surrounding bone of the horizontal ramus is cracked and then peeled away

Fig. 3 Metapodial tools from Botai used to remove cheek teeth from mandibles

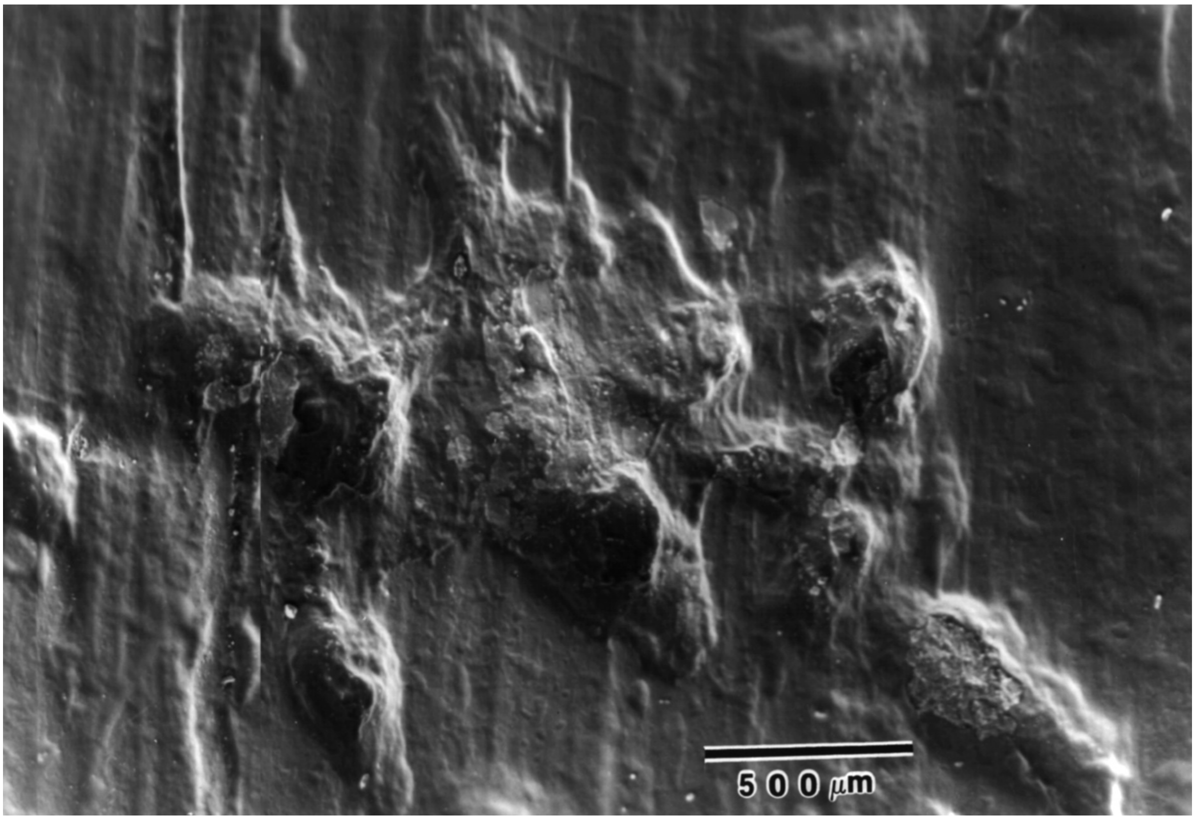

Fig. 4 Distinctive patches of use wear located about 4-8 cm from ends of metapodial tool caused by repeated hammering

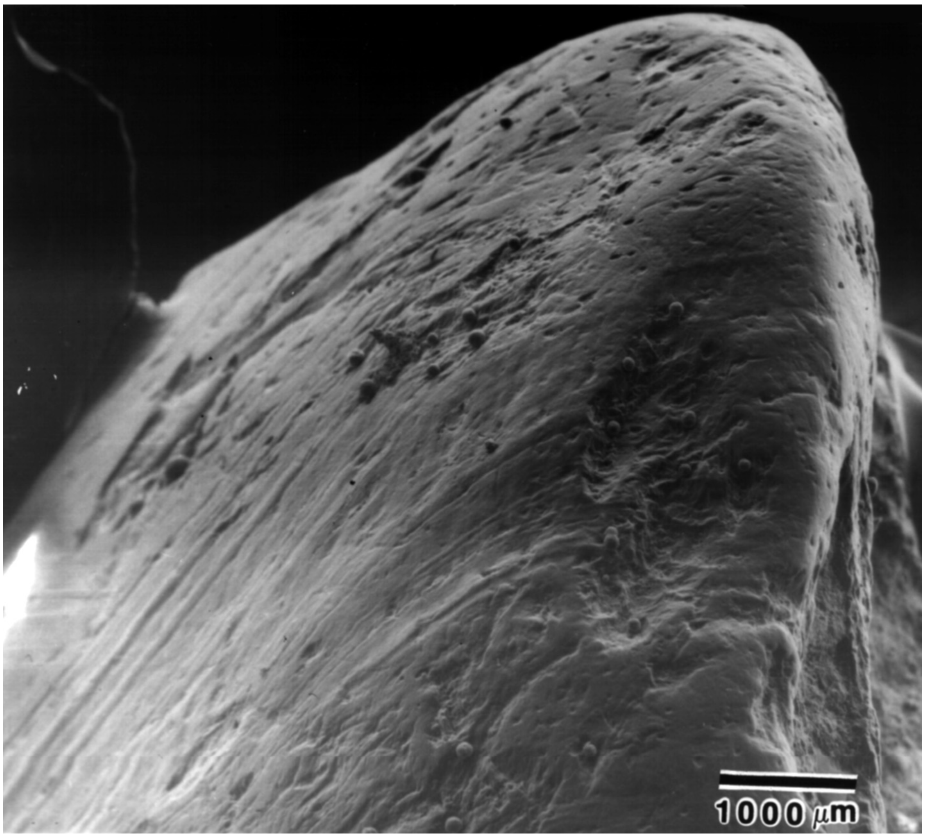

Fig. 5 Tip of metapodial tool showing compression polish, rounding and longitudinal striations running up from end

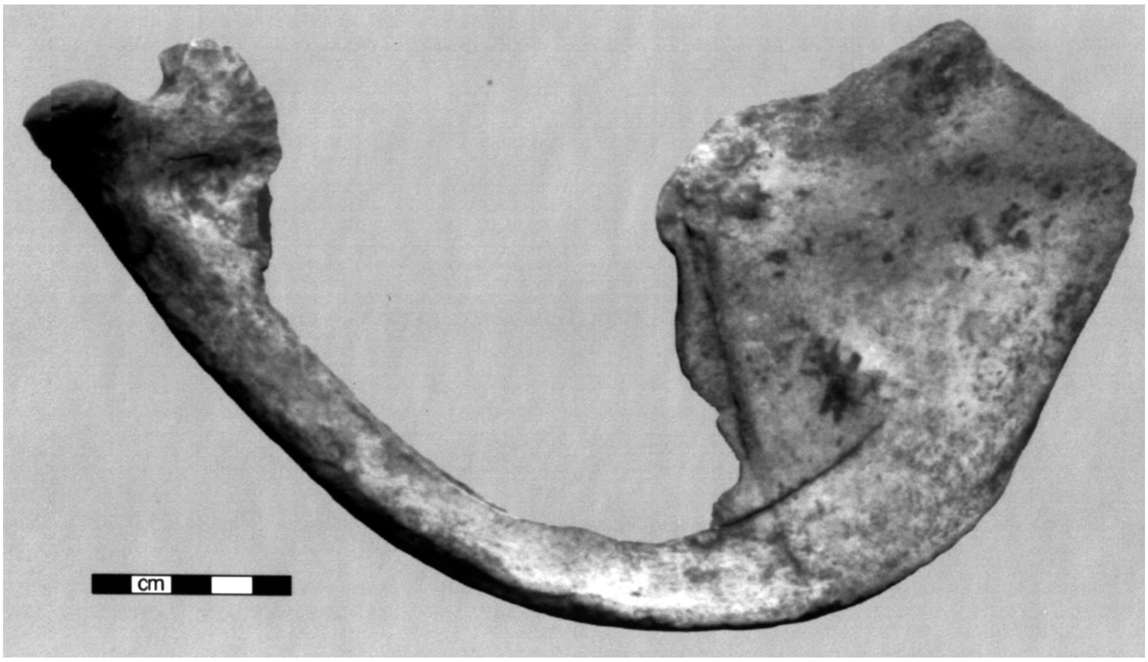

Fig. 6 Unfinished thong-smoother shows how this type was manufactured using the groove and snap technique

Fig. a-c Sickle-shaped thong-smoothers with notches produced by knapping and smoothing

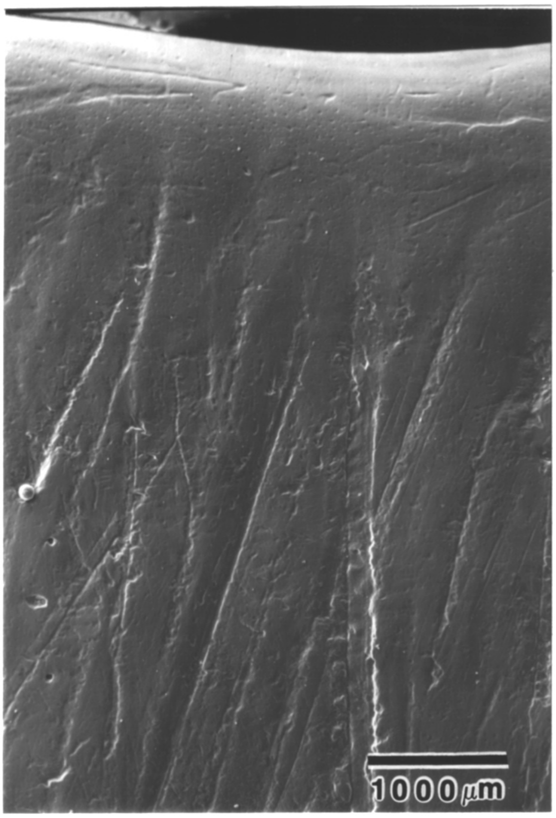

Fig. 8 Abrasion or scraping with a stone tool results in the working edge of the notch being smoothed. Note medium to high wear gloss along working edge

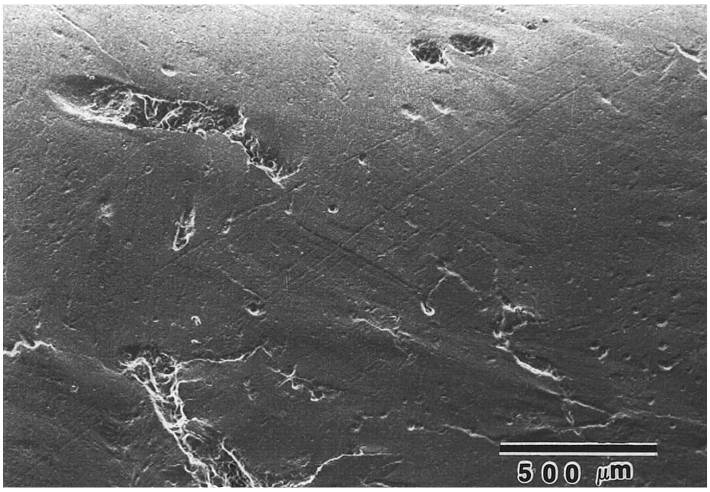

Fig. 9 Edge wear showing very fine striations in the region of the polish, sweeping over the edge and down the surface

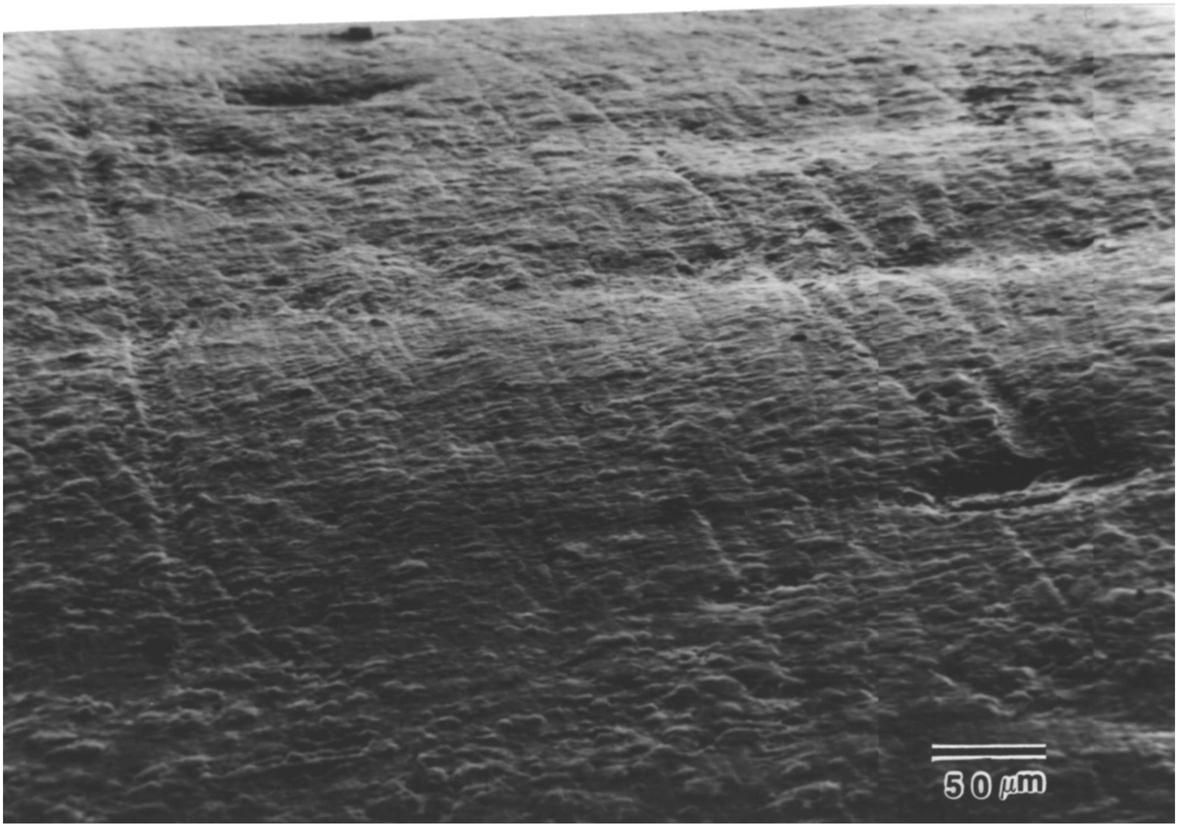

Fig. 10 Experimental horse rib scraper displays virtually identical wear-polish along edge coupled with fine sweeping striae