CRAFTING BONE – SKELETAL TECHNOLOGIES THROUGH TIME AND SPACE

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

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Special Assemblages

Participants in the WBRG 1999 Budapest conference (left to right): Ülle Tamla, Elisabeth Brynja, Tina Tuohy, Liina Maldre, Karlheinz Steppan, Heidi Luik, Gitte Jensen, John Chapman, Alice Choyke, Janet Griffitts, Andreas Northe, Noëlle Provenzano, Jörg Schibler, Nerissa Russell, Colleen Batey, Lyuba Smirnova, László Daróczi-Szabó, Daniella Ciugudean, Mária Bíró, Kordula Gostenčnik, Eszter Kovács, Christopher Morris, Sabine Deschler-Erb, Ans Nieuwenberg-Bron, Katalin Simán, Isabelle Sidéra, Mickle Zhilin

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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.

BONE TOOLS FROM LOS POZOS

Janet Griffitts

Abstract: Los Pozos is a large Late Archaic or Early Agricultural Period site located outside of Tucson, Arizona. Bone awls, spatulate, and side notched tools were examined using high power optical microscopy and a comparative collection of experimentally replicated bone tools. Bone awls were used for various tasks, but the highest concentration of uses involved contact with silica-rich plant materials. Spatulate or chisel shaped tools had several uses including woodworking. One quarter of the awls and chisels were used for multiple purposes, and several tools appear to be recycled after breakage. Notched tools were probably used to process plant fibers. This preliminary study indicates that microwear analysis can be a useful tool for the archaeologist in reconstructing past activities at a site.

Keywords: Use wear, early agriculture, awls, chisels, notched tools

Résumé: Los Pozos est un vaste site de l'Archaïque final ou du Formatif ancien localisé à proximité de Tucson en Arizona. Des alênes en os, des spatules et des outils au bord entaillé ont fait l'objet d'un examen utilisant un microscope optique à fort grossissement et ont été comparés à une série de répliques expérimentales d'outils en os. Les alênes en os ont été utilisées pour diverses tâches, mais les utilisations le plus souvent identifiées supposent un contact avec un matériau constitué de plantes riches en silice. Les outils en forme de spatules ou de ciseaux connurent plusieurs usages parmi lesquels le travail du bois végétal. Un quart des alênes et des ciseaux a été utilisé dans différents buts et plusieurs outils témoignent d'un recyclage après cassure. Les outils entaillés ont probablement été utilisés pour traiter des fibres végétales. Cette étude préliminaire indique que l'étude des micro-traces peut constituer un outil très utile pour l'archéologue dans sa tentative de restituer les activités du passé sur un site.

Mots-clés: Traces d'utilisation, origine de l'agriculture, alênes, ciseaux, outils entaillés

Zusammenfassung: Los Pozos ist ein großer, außerhalb von Tuscon/Arizona gelegener Fundplatz aus der Periode Spätarchaik bzw. Frühe Ackerbaukulturen. Knochenahlen, Spatulae und seitlich gekerbte Artefakte wurden mikroskopisch analysiert und mit experimentell hergestellten Stücken verglichen. Knochenahlen hat man für viele Zwecke verwendet, am häufigsten jedoch im Kontakt mit silikatreichem Pflanzenmaterial. Spatulae oder beilartig geformte Geräte wurden universell eingesetzt, Holzbearbeitung inbegriffen. Ein Viertel aller Ahlen und Beile wurde multifunktional benutzt, manche nach dem Zerbrechen sogar wiederverwendet. Gekerbte Artefakte setzte man möglicherweise bei der Verarbeitung von Pflanzenfasern ein. Diese vorläufige Studie zeigt, daß eine mikroskopisch durchgeführte Spurenanalyse für den Archäologen insofern nützlich sein kann, als hiermit einstige Aktivitäten in einem Siedlungsplatz rekonstruiert werden können.

Schlüsselworte: Abnutzungsspuren, früher Ackerbau, Ahlen, Beile, gekerbte Artefakte

This paper provides a preliminary review of use wear on selected modified bone from Los Pozos, one of several large Late Archaic or Early Agricultural Period sites recently discovered along the Santa Cruz floodplain outside Tucson, Arizona (Mabry et al. 1997; Mabry ed. 1998; Gregory ed. 1999). A variety of bone tools were recovered during the excavations but this study focuses on three general tool types: awls, spatulate tools, and notched tools. The tool surfaces are generally well preserved, providing an opportunity to distinguish the uses of the individual tools and identify possible activities conducted at the site.

Approximately 260 pit structures were exposed during investigations at the site, and more than half were excavated. Domestic refuse deposits within the pit structures and extramural features produced a substantial assemblage of artifacts and other materials. Over 30,000 fragments of animal bone were recovered, including 288 pieces of modified bone. Although the faunal assemblage is dominated by small mammals, especially lagomorphs (Wöcherl 1999; Rebecca Dean, personal communication 1999), the majority of identifiable tools were made from artiodactyl long bones (Gregory and Waters 1999).

Forty-one AMS dates from Los Pozos place the occupation between approximately 350 B.C. and A.D. 50, in the Late Cienega phase, the Early Agricultural Period (fig. 1). The Early Agricultural period lasted at least 1500 years in

Southern Arizona and spans the interval between the arrival of maize and the advent of a fully developed ceramic container technology in the American Southwest (Huckell 1995, 1996). In the last decade, new data concerning this interval have reshaped research foci and substantially altered previous interpretations of the transition from hunting and gathering to agriculture-based subsistence-settlement systems in this region. Among the important research issues are the duration, continuity, and intensity of settlement occupations, and the range of activities carried out during site occupation (Gregory and Mabry 1998). It is in this arena that use-wear studies of bone tools can contribute significantly to ongoing research.

Methods and materials

Use wear analysis was conducted on the modified bone assemblage using high power optical microscopy with an Olympus OHM-J metallurgical microscope with incident light at 50, 100, 200, and 400X magnification, and a comparative collection of modern tools with replicated wear. Tools were also examined using a 10X hand lens and the unaided eye. The experimental program is ongoing and at present includes 198 tools and 60 experiments in which tools were used in a variety of motions and materials. The following discussion describes wear seen at magnifications of 50X and upwards, and the discussions therefore will not be useful for identifying use wear patterns at lower magnifications.

Use wear analysis takes place at multiple stages and levels. One can determine if a tool was likely to have been used at all, what area of the tool was used, the direction of use, and the possible contact material or materials. Lithic studies (Bamforth et al.1990) show that reliability decreases with each of these levels of analysis and this is most likely true for bone, as well. However, use wear analysis provides an additional tool for identifying possible activities at archaeological sites. It works best when used in conjunction with other tools, such as archaeological context, and should not replace all other analytical or interpretive methods.

Use wear generalizations

Experimental studies show that different materials, motions, and ambient conditions leave distinctive microscopic wear patterns on bone and antler (LeMoine 1997, Olsen 1980, 1989, Griffitts 1997). These wear patterns are composed of several characteristics, including polish, striations, surface rounding or flattening, distribution, pitting, cracking, and microbreakage. The extent, brightness, and overall appearance of polish varies with different materials. Striations show the general direction of tool movement, and the size and depth vary with the texture of the material contacted.

Leather and hide working tools become polished and microscopically rounded as the wear follows the contours of the bone surface (fig. 2). There are subtle differences in wear between tools used to process fresh hide and to work tanned leather, but the two categories are combined in the following discussion. Other soft materials, such as cotton, can also produce a rounded tool surface, but there are differences in the appearance of the polish, the extent of wear, and the presence or absence of pitting and cracking.

Tools used to work silica-rich, non-woody plants also become polished; but, unlike wear formed by softer materials, polish and other traces are concentrated on the high points of the tool, and does not extend deeply into lower parts of the bone surface (fig. 3). The surface of heavily worn tools becomes sheared off, and cracking is often visible at 400X magnification. The striation patterns on experimental tools vary slightly between tools used to manufacture coiled, wicker, and sewn baskets, but all have flattened surfaces characteristic of contact with silica-rich plants. The degree of polish varies with different plants, and the duration of use. Additional descriptions and illustrations of these and other wear patterns are found elsewhere (Griffitts and Bonsall this volume, Griffitts 1997).

Activities other than direct use can affect wear on tools, which must be distinguished from other patterns. Hafting can produce wear on tools, and not surprisingly, hand wear is generally similar to that produced by contact with leather or hides. Therefore, wear on handles was noted, but unless it was unusual, it was not included in discussions of use and contact material.

The appearance of use wear can be affected by post-use burning. As tool surfaces become blackened they also become shinier and more rounded. Consequently burned tools may be more likely to be erroneously identified as used on softer materials and the polish may be brighter than it would normally appear if unheated. When bone becomes calcined the surface becomes less reflective, and traces become more difficult to see. If bone is extremely calcined then wear traces disappear (Griffitts 1996).

Tools were grouped into general categories by use and contact materials. Such a coarse grained approach necessarily loses some information on the exact motions and degree of wear on individual tools but is helpful for identifying overall use patterns. More detailed information was recorded for each tool and will be used for additional studies.

Archaeological tools: awls

The modified bone assemblage from Los Pozos includes 106 pointed objects which could be classified as awls, pins, uneyed needles, an eyed needle or bodkin, and tip fragments (fig. 4). Several broken handles were also found, but these are not included in the present discussion. Descriptions of manufacturing techniques are found elsewhere (Gregory and Waters 1999).

Of the 106 tools, 11 (10.4%) have wear consistent with working leather or hide, and four others have wear suggesting contact with unknown soft materials. The soft material could be leather/hide, or it could be a different material, but the wear lacks certain characteristics diagnostic of leather or hide working such as pitting and the overall polish appearance. Tools with wear suggesting contact with leather/hide and general soft materials were combined to simplify (tab. 1).

Most of the awls that have wear resembling that produced by contact with leather or hide have longitudinal striations, occasionally accompanied by a few transverse or diagonal striations that are similar to those produced experimentally by punching holes using little or no twisting. The striations formed in this manner are predominantly longitudinal, although a few diagonal or transverse striations may be present if the tool was twisted. Therefore, the primary function of these tools is interpreted as punching holes in leather or hide (fig. 5).

Tools with wear suggesting contact with silica-rich plants were grouped into two categories: basketry and a general plant category. Twelve awls have wear which is very similar to that produced on experimental basket making tools (fig. 6). Some additional basketry tools may be among the 16 tools included in the silica rich plant category, but because their wear patterns do not completely match the experimental basket making tools, they were placed in the more general category. Many other activities could involve contact with silica rich plants including the production of mats, clothing, and other textiles, such as those found in dry cave sites of similar age in Northern New Mexico (Morris and Burgh 1954). Two tools have wear suggesting plant splitting or stripping as a primary use. The surface of these tools is flattened, with grouped transverse, parallel striations running inward from the edge of the tool shaft, a pattern that was produced experimentally by splitting yucca and beargrass leaves for wicker basketry, stripping yucca and agave for fiber, and corn husking. The wear on a flat, blunt awl is restricted to the tip. The tool has a flattened surface and short transverse striations, suggesting possible rubbing motions with silica rich plants.

A single large needle or bodkin was recovered. The surface is microscopically flattened and predominantly longitudinal striations suggest that the entire piece passed through silica rich plants. An earlier analysis (Gregory and Waters 1999) suggested that this tool could have been used to attach thatch to pit structures, and the wear pattern is consistent with such an activity, although other activities could cause a similar pattern. A few awls have wear that is not diagnostic of either leather/hide/soft materials or of silica rich plants. Two tools have wear consistent with pressure flaking. Another appears to have contacted wood, and one either wood or bark.

One quarter of the awls seem to have had multiple purposes. Multiple uses were interpreted by differences in size, depth, and arrangement of striations, and by other aspects of use wear such as polish and surface texture. Some tools have markedly different wear patterns on different areas of the tool. For example, six tools have wear suggesting that fibers were drawn across an edge of the shaft or near the handle. The same tools have other wear patterns on their tips suggesting that area was used for other activities, such as basket making. Ten tools have wear consistent with contact with both silica-rich plants and a soft material and ten others have wear suggesting multiple use with plants. Seven tools have wear indicating multiple use but the contact materials are unclear. Since later use may obliterate traces of earlier activities, more multiple use tools may have gone unrecognized. Microwear develops at varying rates for different contact materials and activities. This analysis can only identify tools which were used for each activity long enough to create wear.

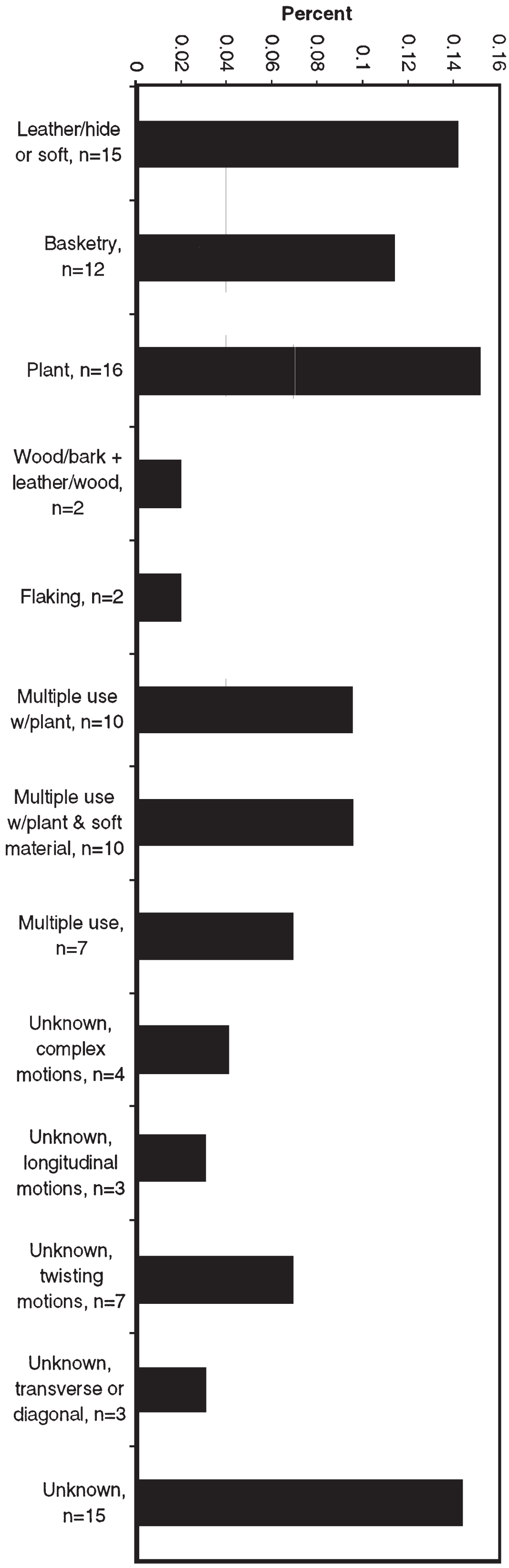
Although the contact material could not be identified for 17 awls, striations were often present that could be used to interpret the direction or directions of movement. No aspect of use could be determined on 15 (14%) of the tools. In some cases this was because the tools were deteriorated, or the wear was too light. Tools may have been used on a material that did not create diagnostic traces. They may not have been used long enough for wear to develop, or produced wear that was entirely different from the range of patterns produced experimentally.

Chisels

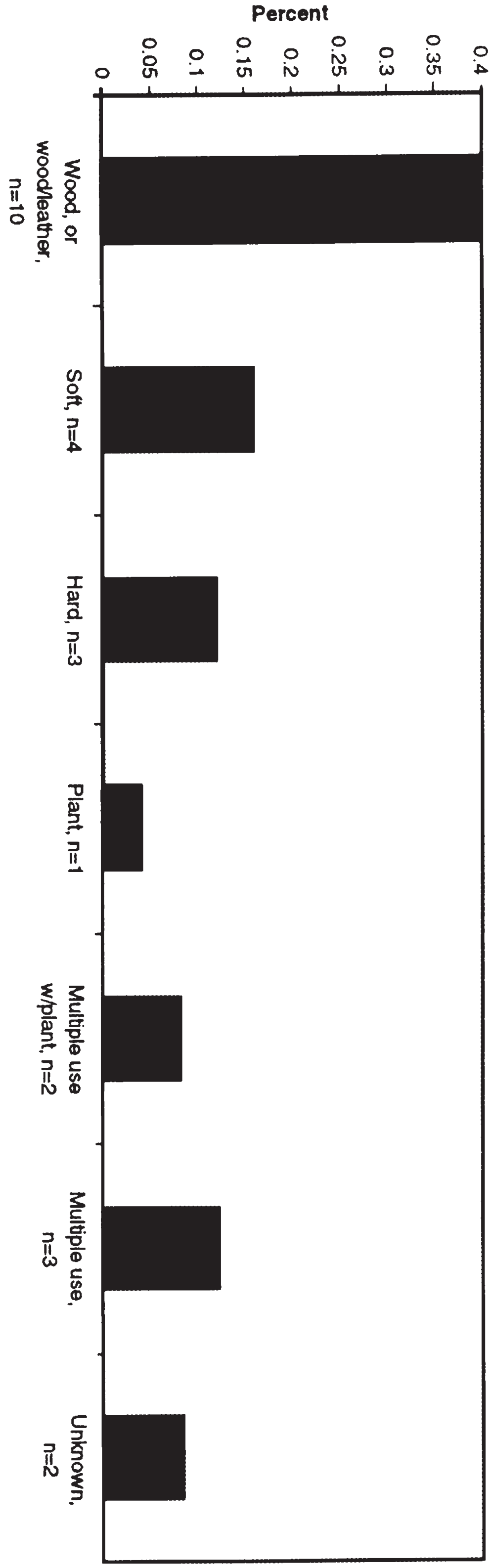
The collection includes 25 long bone tools with roughly spatulate ends and uses are shown in tab. 2. Thirteen have beveled or chisel-shaped ends and are approximately the same size and shape. There are also two wide spatulate tools, two long extremely narrow tools, and several flaked, end-used tools. They are grouped together in this discussion because of similarities in use and overall morphology (fig. 7). It has been suggested that spatulate tools from Santa Cruz Bend, another Early Agricultural Period site, were used to mix or spread materials (Thiel 1998:434). Unfortunately, tools may preserve few traces of such activities if the contact materials were very soft. Others suggest that spatulate tools were used as fleshers (Haury 1950; Morris and Burgh 1954), flakers or scrapers (Kidder and Guernsey 1919), or that the more robust specimens served as digging or prying tools (Morris and Burgh 1954).

Of the 25 tools, five (20%) have wear closely resembling that produced experimentally by wood working (fig. 8). Five other tools have wear that shares similarities with both experimental wood working tools and tools used to work leather or hide. The striations on these tools have a predominantly longitudinal orientation with a few striations running diagonally; a pattern suggesting chiseling or scraping motions. Four tools seem to be used on soft materials, and three on unknown hard materials. Five other tools seem to have received multiple use with different contact materials.

The two broader spatulates were recovered from a feature which also contained three chisel-ended tools. Both are made from bighorn sheep tibiae. The shaft was cut and shaped near the proximal epiphysis, retaining the distal epiphysis as a handle. One is probably a multiple use tool. The surface of the working end is covered with cross hatching striations of vary-



Tab. 1 Percentages of awls used for different activities or contact materials



Tab. 2 Percentages of chisels and spatulate tools used for different activities or contact materials

ing widths and depths. Some striations occur in groups while others are isolated. With so many different uses it would be nearly impossible to identify any individual contact material or materials. The second tibia appears to have been resharpened shortly before discard, and there is not enough continuous wear to suggest its final use. Both tools have wear on the shafts which includes transverse and diagonal striations running from the edges inward. In an earlier report these tools were suggested to be beaming tools, or draw knives used to remove hair from hides (Gregory and Waters 1999). The transverse and diagonal striations on the shafts of both tools could have formed through this activity, but both have been burned and/or calcified so the surfaces are potentially distorted. The wear is also very heavy. The contact material on the shafts could not be identified, but both tools appear to have had more than one use.

Although most of the chisels or end-used tools were formally shaped by cutting and grinding into chisel or spatulate form, three tools were shaped by flaking or chipping. Two artifacts appear to be recycled from other tools. One proximal ulna was probably originally used as an awl but was broken. Wear on the unmodified break indicates use in a longitudinal motion on wood or leather. The second reused tool was also probably an awl. Longitudinal striations and a flattened surface run across the sharp broken edge suggesting longitudinal motions on silica rich plant. A few centimeters from the tip, transverse and diagonal striations also seem to have originated from contact with plants in a twisting motion, but these may be left over from the tool's original pre-breakage use.

An additional tool, not included in table 2, could be classified as either a very wide awl or a narrow spatulate. The surface resembles that produced by working with wood or willow bark. At least two sizes of transverse striations are found around both sides of the tip. These striations extend only a short distance inward from the edge and have not been found on any experimental tools. They may have been produced by pressing bark or wood with the edges, very short scraping motions, or by very short twisting motions.

Notched tools

The Los Pozos assemblage includes one fragmentary artiodactyl scapula (fig. 9). Worn notches along the broken edge of the blade are macroscopically rounded and heavily worn, as is the blade edge. Transverse and diagonal striations run across the edge, indicating that a fibrous material was drawn across it. The flattened surface suggests contact with silica rich plants and overall the patterns are most similar to those produced experimentally while processing yucca or agave for fiber (fig. 10).

A second fragmentary bone has three biconically drilled holes along one margin and is broken longitudinally along the holes. Very fine transverse and diagonal striations run across the broken edges and the insides of the prepared holes. It is not clear why a tool would be prepared in this way, but it may be an object manufactured for an entirely different use that was recycled after breakage.

Notched ribs and scapulae are generally suggested to be plant fiber processors, although a few alternative interpretations have been offered. Thiel (1998) suggests that they may have served to either process fibers or to shell maize. Huscher and Huscher (1943) report ethnographic examples in which similar tools were used for many different tasks, and suggest that tools from Colorado were used to remove hair from deer hides or as seed beaters. An early experimental study (Morris and Burgh 1954) showed these tools to be effective for processing yucca for fibers but not for processing animal hides. Morris and Burgh also recovered artifacts from dry caves which still had yucca residue adhering to the notched surfaces. A sample of Morris and Burgh's tools was examined using microwear analysis and the wear was found to be consistent with yucca processing (Mobely-Tanaka and Griffitts 1997). The present study includes only two artifacts, but this small sample lends support to earlier assertions that notched scapulae were used to process plants, and most likely to strip yucca or agave fibers. The drilled tool may have contacted finer textured fibers.

Ferg (1998) describes how notched scapula and rib tools are widely distributed across the western United States and are primarily found in the Archaic (Morris 1954, Kidder and Guernsey 1919, 1923). The lack or decrease in numbers of notched ribs or scapulae in later time periods may indicate a change in importance or technology of fiber processing. It seems unlikely that agave or yucca fibers would fall into complete disuse, but later technologies such as ceramic containers or weaving cotton may have lessened the need to produce very large quantities of fiber. Certainly the tightly woven water baskets described by Kidder and Guernsey (1923) would no longer have been as necessary with the adoption of pottery.

Discussion and conclusions

One quarter of the awls and chisel shaped tools appear to have had multiple use, and other tools were recycled. Resharpening and reuse are indicated by several traces. In most cases, if a tool is thought to be resharpened, large "v" shaped striations, similar to those produced by grinding during manufacture, cut across older polished and worn areas. These more recent traces may obliterate enough older wear to make use wear analysis difficult. In other cases, tools are broken and reused with little or no additional modification. It is important to note that the traces of reuse, resharpening, and reworking are probably only visible for a relatively short duration in a tool's use life.

It should not be surprising that tools were reused frequently. The same qualities that make bone a desirable tool material can also make it tiresome to work. It is logical that once a metapodial has been laboriously sawn, split, and ground to shape into an awl or other tool, efforts might be made to extend the life of the tool.

Microwear analysis is useful for reconstructing artifact life histories, but it is also a good tool for identifying important prehistoric activities. These activities may involve perishable materials, for which there are few or no other traces. In some cases use wear analysis supports earlier interpretations of tool use that were based on context, ethnographic accounts, and overall form. In other cases use wear can provide supplementary data for objects whose uses have been unknown or were debated. A variety of uses are documented ethnographically for pointed tools, and the present research lends support to the interpretation that many, though not all, were general purpose tools.

The bone tools from Los Pozos were used for many activities. Although maize had already arrived in the Southwest in the Early Agricultural Period, and clay figurines, miniature pots, and balls were present, ceramic container technology was not yet important, and the bone tool assemblage shows emphases on basket making, fiber processing, and wood working. Leather or hide processing was also important.

This study provides a preliminary look at the bone industry of the Early Agricultural period in the Tucson Basin and presents a case study of the use of microwear analysis on bone. Bone tools represent a previously under-exploited resource for the archaeologist, and use wear analysis can provide an additional perspective on the range of activities conducted at a site. Rather than simply listing morphological types in a table or an appendix, more detailed and intensive studies can help add a new perspective and increase our knowledge of the range of activities conducted on site. The information in this report will be added to studies of other bone artifacts and other industries and features at Los Pozos. Future studies will examine other modified bone from Los Pozos and from this and other time periods and attempt to identify possible form/function correlations and patterns of overall bone tool use as well as technological change and stability.

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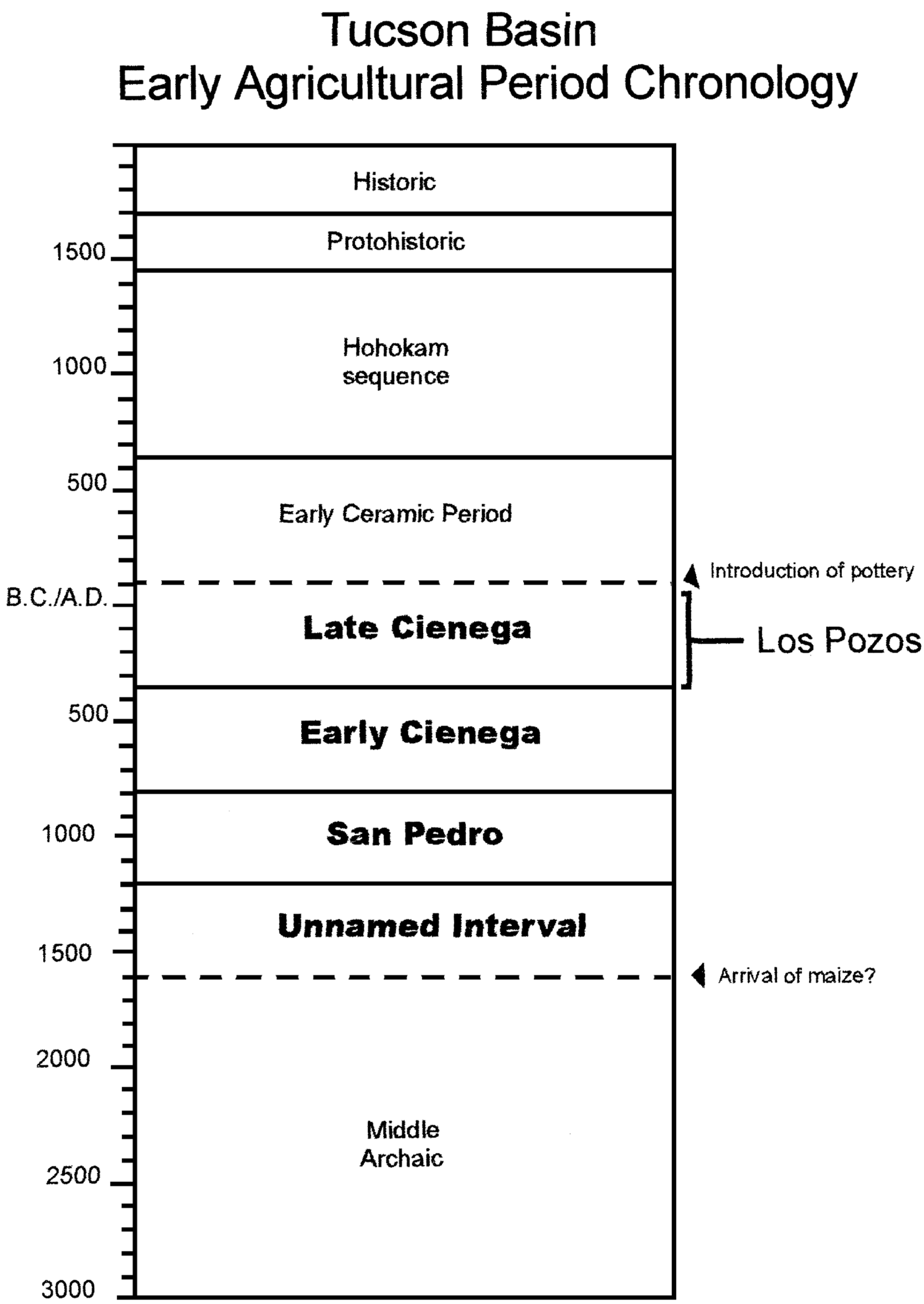

Fig. 1 General Chronology of Southern Arizona. Table provided by D. Gregory, Desert Archaeology

Fig. 2 Wear formed experimentally by punching holes in leather (100X magnification)

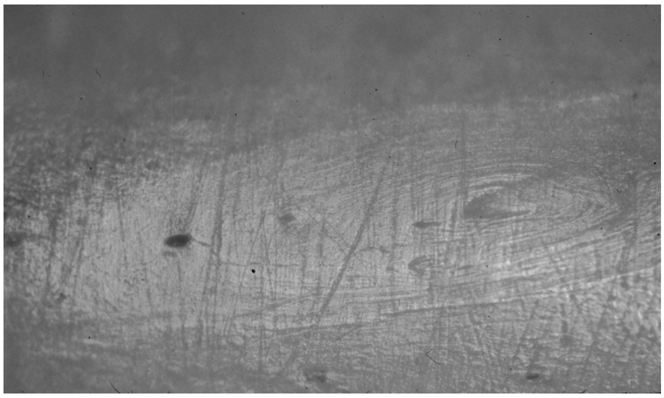

Fig. 3 Wear formed experimentally during basket making. (100X magnification)

Fig. 4 Examples of awls from Los Pozos

Fig. 5 Wear consistent with leather or hide working (100X magnification)

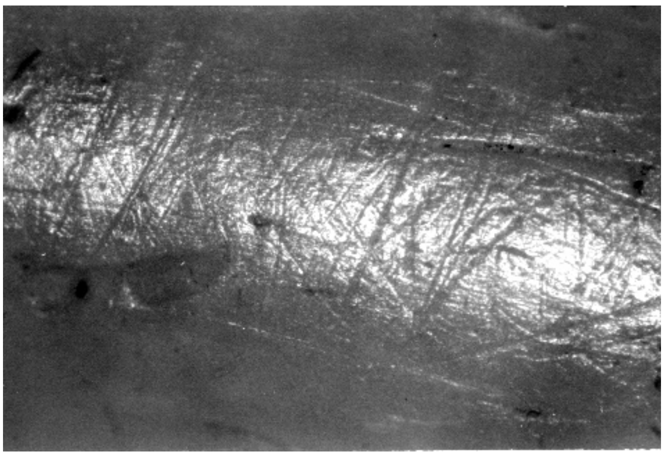

Fig. 6 Wear consistent with inserting and twisting in plant fibers, or basket making (100X magnification)

Fig. 7 Examples of chisels and spatulates from Los Pozos

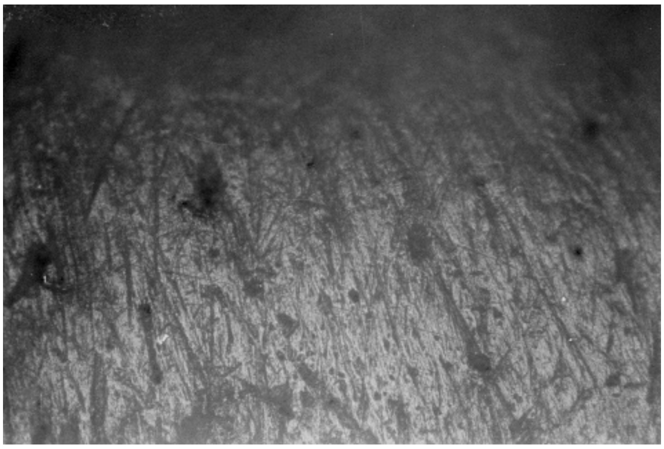

Fig. 8 Wear on chisel consistent with wood working (100X magnification)

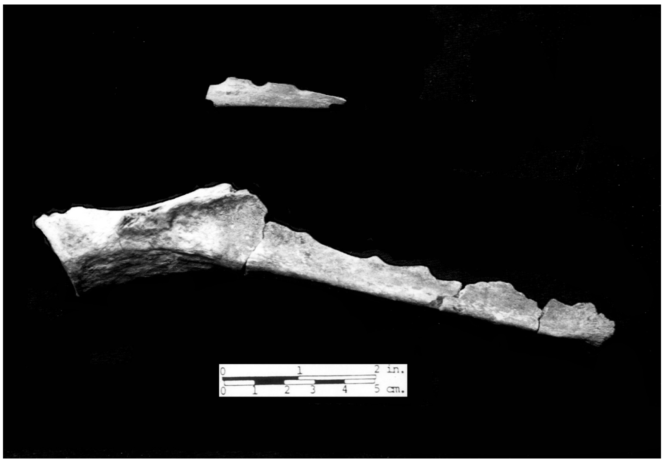

Fig. 9 Notched tools from Los Pozos

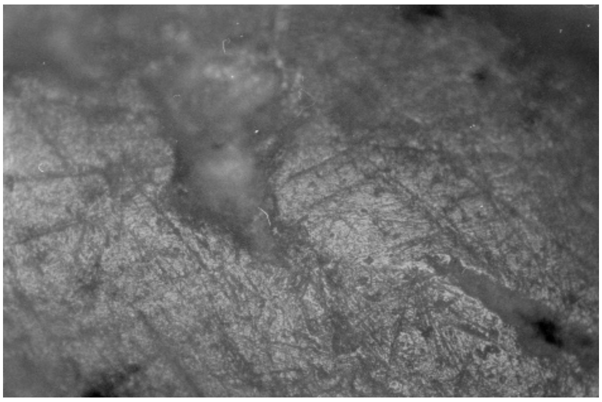

Fig. 10 Wear on notched tool consistent with plant processing (100X magnification)