CRAFTING BONE – SKELETAL TECHNOLOGIES THROUGH TIME AND SPACE

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

Editors

Alice M. Choyke & László Bartosiewicz

Technical editors

Krisztián Kolozsvári
Mrs. Katalin Kővágó - Szentirmai

Infrastructural support by

The staff of the Roman Department of the Aquincum Museum

Worked Bone Research Group 2nd Meeting
Budapest 31 August – 5 September 1999

BAR International Series

2001

Table of Contents

Introduction . . . . III-IV

General Theory

Genevieve LeMoine – *Skeletal Technology in Context: An Optimistic Overview* 1

Raw Material Exploitation

Lyuba Smirnova – *Utilization of Rare Bone Materials in Medieval Novgorod* 9
Liina Maldre – *Bone and Antler Artefacts from Otepää Hill-fort* 19
Sabine Deschler-Erb – *Do-it-yourself Manufacturing of Bone and Antler in Two Villas in Roman Switzerland* 31
Rosalia Christidou – *Study of Bone Tools at Three Late/Final Neolithic Sites from Northern Greece* 41

Manufacturing Technology

Jörg Schibler – *Experimental Production of Neolithic Bone and Antler Tools* 49
Daniella Ciugudean – *Workshops and Manufacturing Techniques at Apulum (AD* 2^{nd}*-*3^{rd} *Century)* 61
Kitty F. Emery – *The Economics of Bone Artifact Production in the Ancient Maya Lowlands* 73
Karlheinz Steppan – *Worked Shoulder Blades: Technotypological Analysis of Neolithic Bone Tools From Southwest Germany* 85
Noëlle Provenzano – *Worked Bone Assemblages from Northern Italian Terramares: A Technological Approach* 93
Aline Averbouh – *Methodological Specifics of the Techno-Economic Analysis of Worked Bone and Antler: Mental Refitting and Methods of Application* 111

Function

Mária Bíró – *A Round Bone Box Lid with a Mythological Representation* 123
Cornelia Becker – *Bone Points - No Longer a Mystery? Evidence from the Slavic Urban Fortification of Berlin-Spandau* 129
Mickle G. Zhilin – *Technology of the Manufacture of Mesolithic Bone and Antler Daggers on Upper Volga* 149
Tina Tuohy – *Bone and Antler Working on the Iron Age Sites of Glastonbury and Meare in Britain* 157
Gitte Jensen – *Macro Wear Patterns on Danish Late Mesolithic Antler Axes* 165
Yekaterina Antipina – *Bone Tools and Wares from the Site of Gorny (1690 - 1410 BC) in the Kargaly Mining Complex in the South Ural Part of the East European Steppe* 171
Andreas Northe – *Notched Implements made of Scapulae - Still a Problem* 179
Janet Griffitts – *Bone Tools from Los Pozos* 185
Sandra L. Olsen – *The Importance of Thong-Smoothers at Botai, Kazakhstan* 197
Janet Griffits and Clive Bonsall – *Experimental Determination of the Function of Antler and Bone 'Bevel-Ended Tools' from Prehistoric Shell Middens in Western Scotland* 207

Social Context

Isabelle Sidéra – *Domestic and Funerary Bone, Antler and Tooth Objects in the Neolithic of Western Europe: a Comparison* 221
George Nash – *Altered States of Consciousness and the Afterlife: A Reappraisal on a Decorated Bone Piece from Ryemarksgaard, Central Zealand, Denmark* 231
Nerissa Russell – *The Social Life of Bone: A Preliminary Assessment of Bone Tool Manufacture and Discard at Çatalhöyük* 241
Alice M. Choyke – *Late Neolithic Red Deer Canine Beads and Their Imitations* 251
Colleen Batey – *Viking and Late Norse Combs in Scotland: An Update* 267
Nerissa Russell – *Neolithic Relations of Production: Insights from the Bone Tool Industry* 271

Special Assemblages

Péter Gróf and Dániel Gróh – *The Remains of Medieval Bone Carvings from Visegrád* 281
László Bartosiewicz – *Roman Period Equid Ilium Implement from Pannonia Superior (NW Hungary)* 287
E.E. Bulten and Anneke Clason – *The antler, bone and tooth tools of Swifterbant, The Netherlands (c. 5500 – 4000 cal. BC) compared with those from other Neolithic sites in the western Netherlands* 297
Heidi Luik – *Bone Combs from Medieval Tallinn, from the Excavations in Sauna Street* 321
Steven R. James – *Prehistoric Hohocam Bone Artifacts from Southern Arizona: Craft Specialization, Status and Gender* 331
Arthur MacGregor and Ailsa Mainman – *The Bone and Antler Industry in Anglo-Scandinavian York: the Evidence from Coppergate* 343
Ernestine Elster – *Middle Neolithic to Early Bronze Age Bone Tools from Sitagroi, Greece* 355
Ülle Tamla and Liina Maldre – *Artefacts of Bone, Antler and Canine Teeth among the Archaeological Finds from the Hill-Fort of Varbola* 371
Kordula Gostenčnik – *Pre- and Early Roman Bone and Antler Manufacturing in Kärten, Austria* 383

Index of Authors 399

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

CRAFTING BONE - SKELETAL TECHNOLOGIES THROUGH TIME AND SPACE

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

Budapest, September 1999

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.

MIDDLE NEOLITHIC TO EARLY BRONZE AGE BONE TOOLS FROM SITAGROI, GREECE

Ernestine S. Elster

Abstract: Sitagroi is located in northeast Greece. It is one of a number of prehistoric sites on the plain of Drama. The sequence is framed by 29 radiocarbon dates which extend from ca. 5400 to 2300/2400 BC in calibrated years. Five cultural phases were established from the middle Neolithic to the early Bronze Age. Principal investigators were Colin Renfrew and the late Maria Gimbutas. The second and final monograph (Elster and Renfrew, in press) includes, among other sets of data, the full report and catalogue of the bone artifacts (Elster, in press). This shorter contribution presents tabulations of the taxa and the skeletal elements selected for tool manufacturing over time, the types produced, and an examination of two forms, pointed pieces and elaborated bone artifacts. Various problems and pitfalls in the analysis of aging data will also be discussed.

Keywords: Sitagroi, northeast Greece, Neolithic-Bronze age, raw materials, types, old data

Résumé: Sitagroi est situé en Grèce du Nord-Est. C'est l'un des nombreux sites préhistoriques de la plaine de Dramma. Son occupation est calée par 29 datations radiocarbones qui s'échelonnent entre 5400 cal. BC et 2300/2400 cal. BC. Cinq phases culturelles ont pu être distinguées, depuis le Néolithique moyen jusqu'au Bronze ancien. Colin Renfrew et Marija Gimbutas furent les principaux chercheurs à travailler sur ce site. La seconde et dernière monographie (Elster et Renfrew, sous presse) comprend, parmi d'autres ensembles de données, le catalogue et l'étude complète des objets en os (Elster, sous presse). Moins détaillée, la présente contribution expose l'identification anatomique des supports travaillés, et examine deux types d'objets: les objets pointus et les artefacts élaborés. Elle discute également divers aspects concernant les problèmes et les écueils de l'étude des collections provenant de fouilles anciennes.

Mots-clés: Sitagroi, Grèce du Nord-Est, Néolithique, Age du bronze, matières premières, typologie, données issues des fouilles anciennes

Zusammenfassung: Sitagroi liegt in Nordostgriechenland. Es ist einer der vielen prähistorischen Fundplätze in der Ebene von Drama. Die Schichtenabfolge wird von 29 Radiokarbondaten (etwa 5400 bis 2300/2400 calBC) eingegrenzt. Fünf Kulturphasen vom Mittleren Neolithikum bis zur Frühen Bronzezeit wurden erkannt. Colin Renfrew und die verstorbene Marija Gimbutas waren die Hauptausgräber. Neben anderen. Datenpaketen enthält die zweite und abschließende Publikation (Elster und Renfrew, in Vorber.) einen vollständigen Bericht und Katalog zu den Knochenartefakten (Elster, in Vorber.). Dieser kürzere Beitrag bietet eine Aufzählung der Taxa und der Skelettelemente, die für die Knochenbearbeitung über die Zeiten hin ausgewählt wurden, nennt ferner die hergestellten Typen und bietet eine Untersuchung zweier Formen, Spitzen und besonders aufwendig gestaltete Artefakte. Diverse Probleme und Fallstricke in der Analyse der Altersdatierung werden ebenfalls diskutiert.

Schlüsselworte: Sitagroi, Nordostgriechenland, Neolithikum bis Bronzezeit, Rohmaterialien, Typen, alte Daten

Introduction

Thirty years ago the third and final season of the UCLA-Sheffield University excavations at Sitagroi in northeast Greece came to a close. Principal Investigators were Colin Renfrew and the late Marija Gimbutas. The first of the two volume monograph reporting on this research (Renfrew et al 1986) includes Sándor Bökönyi's report of the refuse bone (Bökönyi 1986: 63-132) and will be referred to frequently.

Sitagroi, one of a number of prehistoric mounds on the plain of Drama, lies ca. 25 km inland from the northern Aegean (fig. 1). The sequence is framed by 29 radiocarbon dates which extend from ca. 5400 to 2300/2400 BC in calibrated years (Renfrew 1986:172-73). Five cultural phases were established: Middle Neolithic Phases I (5500-5200 BC) and II (5200-4600 BC), Chalcolithic Phase III (4600-3500 BC), and the Early Bronze Age Phases IV (3500-3100 BC), and Va, b (3100-2200 BC; Clark 1975). At the time of abandonment, the magoula rose 10.5 m above the level of the plain and appeared as it did to us, as a low lying, gently sloping mound.

The second and final monograph (Elster and Renfrew, in print) includes, among other sets of data, the full report and catalogue of the bone artifacts (Elster, in press). This shorter contribution presents tabulations of the taxa and the skeletal elements selected for tool manufacturing over time, the types produced, and an examination of two general forms: pointed pieces and elaborated bone artifacts.

Various problems and pitfalls inevitably pose a challenge in the study of aging data. For example, I am physically removed from the corpus which is in Greece and although I participated during two of the three field seasons, that was 30 years ago (1968 and '69). Regrettably, Sándor Bökönyi, who knew the bone assemblage well, is now deceased. However, I was able to consult with specialists, Nerissa Russell and Alice Choyke[1].

Since the Worked Bone Research Group meeting in Fall 1999, all questionable "shoat metapodial" data has been reexamined but it was Nerissa Russell who solved the problem when she realized that "shoat" was an abbreviation used occasionally for sheep/goat. The pitfall lay in the tabulation of this "shoat" identification as domesticated pig! The Catalogue was duly corrected, and this report is based on that document, plus inventory cards, notebook, line drawings, and plates of a representative sample (100 artifacts) of the assemblage.

When the counts of artifacts from the two Middle Neolithic (MN=Phases I and II) plus the Chalcolithic (C=Phase III) or the two Early Bronze Age (EBA= Phases IV and Va, b) are combined on the tables of cross-tabulations and discussion, the following abbreviations used are, MN/C and EBA.

The Raw Materials

The assemblage of 613 artifacts was manufactured on the skeletal elements of all of the five domesticated animals identified in the refuse bone: cattle, sheep/goat, pig, dog, along with six of the 29 wild animals: wild swine, red, fallow, and roe deer, aurochs, and tortoise (Bökönyi 1986: 96-97). The carapace of tortoise is of course, a kind of skeletal material, along with all shell; however, with the exception of the five carapace specimens, the large shell recovery is not part of this bone study[2].

Representing 3000 years of occupation, and it is unlikely that this was continuous, the refuse bone totaled over 34,473 specimens (Bökönyi 1986: 68). Of that number, the percentage of specimens from domesticates averaged 91.0 percent and the remainder were from wild animals. Tab. 1 is based on Bökönyi's (ibid.) tabulation of each Phase. The six wild animals whose elements were used as raw material for the manufacture of artifacts represent 80.0 percent of the total refuse wild bone. Red deer makes up 38. 0 percent of that number. As in many prehistoric sites of northern Greece (Larje 1987: 94; Seferiades 1992: 99) and the Balkans, this wild species provided raw material of considerable importance (Bökönyi 1986: 87). Although most tools were manufactured on bone elements from domesticated animals, red deer antler was a special raw material and had its own use trajectory.

Tab. 1 is presented as if the settlement existed continuously over 3000 years, but since dates for Phases III and for Va, b each cover over 1000 years, probably the mound was abandoned and resettled several times. Although I treat the assemblage as a whole for this report, it undoubtedly represents several separate and distinct episodes of occupation with concomitant human activities of differing focus: plant and animal husbandry, house building, gathering, hunting, scavenging, tool making, trading, etc. Indeed, the forms of bone artifacts change very little over time, a general observation concerning bone tools, which has been noted (Russell 1990: 546). That is due, in part, to what lithic scholars refer to as "mechanical contingency", the properties of the raw material, such as shape, flaws, size, etc., which are taken into consideration as the knapper commences tool manufacture (Sackett 1966). In the same way (Choyke 1998: 171), a long bone lends itself to being formed into a sharp pointed tool whereas the beam of an antler does not. In the case of bone tools, function follows forms.

The faunal recovery has been reported as all kitchen refuse (Bökönyi 1986: 65), thus (c.f. tab. 1) the majority of meat protein came from the kept animals, a pattern repeated at other sites of Neolithic and EBA north Greece (Yannouli 1994: 330). Hunting and/or scavenging was not as important to subsistence but could have provided a special "treat", or a traditional meal for a feast or celebration, or, more practically, as risk protection in times of herd failure, and raw material for tools and other artifacts.

Antler, much prized, provides evidence of a successful hunting or scavenging expedition; it is extremely resilient, absorbs shock without splitting, and when the inner spongy core of a section of the rack is removed, the remaining sleeve can hold another tool (Choyke 1998: 171-172). Also, the number of artifacts which can be manufactured from an antler rack (fig. 2), is potentially greater than from any other element. Bone artifacts number 452 and antler 161; since antler and bone properties differ so, I consider each separately.

Well over half of the bone count (252 = 56.0 %) is manufactured on elements from unidentifiable taxa (tab. 2). It is unfortunate that we cannot incorporate this large number of tools on all of the tabulations since identification of even one-fourth of these could change the relative percentage of domestic versus wild raw material selection. Nevertheless, from the controlled sample of 200 artifacts for a 3000 year spread, 65.0 percent came from domesticates (count=130) and 35.0 percent from wild taxa (count=70). Considering the distribution on tab. 1, and even though these tabulations do not present a full picture, the statistics underscore the fact that bone from wild taxa was especially important to the settlers as raw material for tool making probably because elements from wild animals were stronger (Russell 1990: 544,548). The hunt also offered opportunities for participants to show their skill and for leaders to emerge (Rappaport 1968) and the artifacts made on bone elements from "trophy" or other wild animals might well have taken on special significance.

The largest number of tools, using the total count of 452, were recovered from the combined MN/C (count=288 or 64.0 per-

Phase	Period	Domestic %	Wild %
I	Middle Neolithic	91.40	8.60
II	Middle Neolithic	96.53	3.47
III	Chalcolithic	91.88	8.12
IV	Early Bronze Age	82.33	17.67
Va, b	Early Bronze Age	93.48	6.55

Tab. 1 Relative percentage over time for specimens from wild or domesticated taxa as reported in the refuse bone

Taxon	Phases							
Domestic	I	II	III	IV	V	?	Total	%
Cattle (*Bos taurus* L.)	1	2	8	3	8		22	5
Sheep/goat (Caprovine)	9	16	44	9	12		90	20
Pig (*Sus scrofa dom.* L.)	2	3	5		4	1	15	3
Dog (*Canis familiaris* L.)		1	1	1			3	0
Total	12	22	58	13	24	1	130	28
Wild	I	II	III	IV	V	?	Total	%
Aurochs (*Bos primigenius* Boj.)				2			2	0
Red deer (*Cervus elaphus* L.)	1		8	11	1		21	5
Fallow deer (*Dama dama* L.)					1		1	0
Roe deer (*Capreolus capreolus* L.)		1	6	1			8	2
Deer (Cervidae sp.)		2	3	9	1	1	16	4
Wild pig (*Sus scrofa fer.* L.)		4	7	3	3		17	4
Tortoise (Chelonia sp.)			1	2	2		5	1
Total	1	7	25	28	8	1	70	16
Unidentifiable	24	66	73	52	35	2	252	56
GRAND TOTAL	37	95	156	93	67	4	452	100
Percent	8	21	35	21	15	0	100	

Tab. 2 Distribution of artifacts over time manufactured from domesticated or wild taxa (? = No clear contextual data)

cent) rather than the EBA, which includes four surface finds (count = 164 or 36.0 percent). Margaret Lyneis (1988: 318) also commented on the contrast between bone assemblages for Divostin I and II. At Sitagroi this count is affected by the richness of Phase III but also because MN/C covers a longer period of Sitagroi occupation.

Taxa and Elements

Tab. 3 (MN/C) and tab. 4 (EBA) were prepared in order to examine the toolmaker's preference for domesticated or wild taxa and skeletal elements. Results indicate that for MN/C, Caprovine metapodial, tibia, ulna, and astragali are preferred, the latter possibly for use in gaming (Russell 1990: 538-39) or, pierced, as a pendant. From wild taxa, preference was for deer metapodial, especially *Cervus elaphus*, *Capreolus capreolus* and, teeth from wild pig, generally pierced. Counts of other taxa and elements were insignificant except for rib but the animal species are unidentifiable.

During the EBA (tab. 4) fourteen different elements were used from the domesticates, Caprovine metapodial, tibia, scapula, and ulna accounted for almost 25.0 percent; various elements of *Bos taurus* including horn-core, hyoid, scapula, rib, ulna, which, combined, reached 13.0 percent. Among wild taxa, again metapodial was most important, from *Cervus elaphus* and other Cervids. There were also canines from wild pig; some of these were perforated, others were split, in which case they could have been used in cutting (Russell 1990: 531).

Tab. 5 presents the distribution of antler over time at Sitagroi; as mentioned earlier, *Cervus elaphus* is the most frequent wild species represented in Phases I-IV (Bökönyi 1986: 87). Examples of the tools manufactured on antler are illustrated (figs. 3-7). A few explanations for the importance of antler to the settlers at Sitagroi were noted earlier; in addition antler is more easily recognized during excavation and so its significance in the assemblage could reflect excavation bias. Alice Choyke doubts this (1998: 172) because skeletal elements of red deer are consistently found at many Bronze Age sites on the Great Hungarian Plain. The success of the Sitagroi scavenging parties was due no doubt to the fact that the settlers knew that stags shed their racks at the end of winter and beginning of spring and often at the same location and acted on this knowledge.

As indicated on tab. 5, there is increased success in obtaining and working antler through the period of MN/C, but a dwindling production of antler artifacts beginning with the EBA. And this is so even though evidence of hunting is strong in the refuse bone of Phase IV (tab. 1); indeed specimens of red deer increase in percentage over time: Phase II: 1.4; Phase III: 3.7; Phase IV: 6.6 (Bökönyi 1986: 68). A closer look at tabs. 2 and 5 indicates that the change is not in the use of wild animal elements for bone tool production from Phase III to Phase IV (25 tools in III versus 28 in IV); but rather in the use of antler (tab. 5) which decreases from a percentage of 40.0 in Phase III to 10.0 in Phase IV. Deer is being hunted and its skeletal elements used for tools, but the EBA villagers are not as interested in producing antler artifacts. This suggests perhaps a change in agricultural practice. One hypothesis, developed to explain a similar change at Yugoslavian Vinča sites, is that throughout the Neolithic and into the Chalcolithic horticulture took place in household plots. As the population increased and food requirements grew, this practice was eventually replaced by the cultivation of fields in locations (potentially expandable) but away from living spaces. In order to intensify production these new soils were being cultivated with the ard and the simple plow (Chapman 1990: 24,25; Tringham 1990: 593, 594). Therefore, the demand for digging sticks of antler tine (fig. 2) and hoes or mattocks from hollowed and shafted antler beams (fig.1) diminished.

Types

Although the assemblage is divided into antler and other bone, the typology is used with both groupings, focusing on formal variation and modification. All types are discussed in detail in Sitagroi Vol. 2 (Elster 2001a-b); the typology and the line drawings merely give a sense of the variability in the assemblage. Usage is naturally a consideration but only tentatively because these tools were never examined for use wear. Tab. 6 (MN/C) and tab. 7 (EBA) compare the frequency of types as manufactured from bone elements of domestic or wild taxa; tab. 8 does the same for antler. The types include the following:

(1) Pointed pieces, discussed separately below (figs. 8-12).
(2) Bevel/chisel ended tools on antler (fig. 5) or long bone (fig. 13).
(3) End rounded; these are mostly on antler tine (fig. 4).
(4) End flattened; generally sections of antler beams which have been separated from the rack by the cut and break method (Lyneis 1988: 303); ends are modified or worked and become flattened; used as mallet, punch (fig. 6).
(5) Spatula ends; split, flattened bone; probably rib (fig. 14).
(6) Antler beams with shaft hole and socket (fig. 3).
(7) Elaborated piece: perforation (fig. 15), notching (fig. 16), grooving (fig. 17), significant shaping (figs. 7 and 18).
(8) Various modified elements: scapula, probably used in polishing (fig. 19), ulna, with wear along rib and rounded at point (fig.20), and astragali (not illustrated).
(9) Miscellaneous modified and worked pieces of unidentifiable taxa and element (not illustrated).

Pointed artifacts form the most numerous type in the assemblage (42.0 in MN/C; 37.0 in EBA); the several variations include: tools on long bones with single converging tip (fig. 8); points on ribs with one end converging and opposite angled or cross cut (fig. 9); and pieces on unidentifiable elements (probably rib) with one or both ends pointed (fig.10).

The metapodial or rib elements are reduced by splitting and/or grinding, with sides narrowed and smoothed; one or both ends converge to a point (fig. 10); the modified ends are the working surfaces. Termination can be angled and/or chisel-like as on the Phase II point (fig. 9), manufactured on a split rib, its tip worn

Phases	I, II, III													
Domestic	astragalus	humerus	jaw	metapodium	radius	rib	scapula	shell	skull	tibia	tooth	ulna	Total	%
Cattle	1		1	1	1	1			1			5	11	7
Sheep/goat	11	3		41						9		5	69	46
Pig	3						1		1	5			10	7
Dog					1							1	2	1
Total	15	3	1	42	2	1	1		2	14		11	92	61
Wild	astragalus	humerus	jaw	metapodium	radius	rib	scapula	shell	skull	tibia	tooth	ulna	Total	%
Red deer				8									9	6
Roe deer				6						1			7	5
Deer sp.	1			5									5	3
Wild pig											11		11	7
Tortoise								1					1	0
Total	1			19				1		1	11		33	22
Unident.	0			2		21				1	2		26	17
TOTAL	16	3	1	63	2	22	1	1	2	16	13	11	151	100
Percent	11	2	0	42	1	15	0	0	1	11	9	7	100	

Tab. 3 Crosstabulation of elements from domesticated or wild taxa used during the Middle Neolithic/Chalcolithic

Phases	IV, V															
Domestic	fibula	horn c.	hyoid	jaw	metapodium	radius	rib	scapula	shell	skull	tibia	tooth	ulna	vertebra	**Total**	%
Cattle		4	1				3	2					1		11	13
Sheep/goat					8			1			11		1		21	26
Pig	3									1		1			4	5
Dog															1	1
Total	3	4	1		8		3	3		1	11	1	2		**37**	**45**
Wild	fibula	horn c.	hyoid	jaw	metapodium	radius	rib	scapula	shell	skull	tibia	tooth	ulna	vertebra	**Total**	%
Aurochs															2	2
Red deer					12										12	14
Fallow deer											1				1	1
Roe deer					1										1	1
Deer sp.					9	1									10	12
Wild pig				1								5			6	7
Tortoise									4						4	5
Total				1	22	1		2	4		1	5			**36**	**43**
Unident.					1		6	2				1		1	**10**	**12**
TOTAL	3	4	1	1	31	1	9	7	4	1	12	7	2	1	**83**	100
Percent	4	5	1	1	37	1	11	9	5	1	14	8	2	1	100	

Tab. 4 Crosstabulation of elements from domesticated or wild taxa during the Early Bronze Age

Antler	Phases							
Taxon	I	II	III	IV	V	?	Total	%
Red deer	12	39	56	11	7		125	78
Roe deer	3	1	1	1		1	7	4
Deer sp.	8	8	7	4	1		28	17
Total	23	48	64	16	8	1	160	99
Unidentifiable		1					1	1
TOTAL	23	49	64	16	8	1	161	100
Percent	14	30	40	10	5	1	100	

Tab. 5 Distribution of Cervidae antler over time (? = No clear contextual data)

Phases	I, II, III									
Domestic	chisel end	elaborated	flattened end	miscell.	perforated	pointed	round	spatulate	Total	%
Cattle	3	1		5		1	1		11	4
Sheep/goat	6	3	3	21	1	35		1	70	25
Pig	2	2	2	4					10	3
Dog			2						2	0
Total	11	6	7	30	1	36	1	1	93	32
Wild	chisel end	elaborated	flattened end	miscell.	perforated	pointed	round	spatulate	Total	%
Red deer	1		1	4		3			9	3
Roe deer	1					6			7	3
Deer sp.				2		3			5	2
Wild pig		2		9					11	4
Tortoise				1					1	0
Total	2	2		16		12			33	12
Unident.	8	11	11	36		73	9	13	162	56
TOTAL	21	19	19	82	1	121	10	14	287	100
Percent	7	7	7	28	2	42	3	5	100	

Tab. 6 Crosstabulation of domesticated or wild taxa and types during the Middle Neolithic/Chalcolithic

Phases	IV, V								
Domestic	chisel end	elaborated	flattened end	miscell.	pointed	round	spatulate	Total	%
Cattle	1		2	7			1	11	7
Sheep/goat	7		2	4	7	1		21	13
Pig		2		1	1			4	3
Dog		1						1	
Total	8	3	4	12	8	1	1	37	23
Wild	chisel end	elaborated	flattened end	miscell.	pointed	round	spatulate	Total	%
Aurochs				2				2	1
Red deer	1			6	4	1		12	8
Fallow deer	1							1	
Roe deer					1			1	
Deer sp.	2			3	5			10	6
Wild pig				6				6	4
Tortoise		3		1				4	3
Total	4	3		18	10	1		36	23
Unident.	4	9	2	25	39	3	5	87	54
TOTAL	16	15	6	55	57	5	6	160	100
Percent	10	9	4	34	36	3	4	100	

Tab. 7 Crosstabulation of domesticated or wild taxa and types during the Early Bronze Age

down or broken, wear polish noted on the left margin, and the opposite end beveled for use perhaps in scraping or burnishing.

One of the reasons why it is a challenge to design discrete attributes for bone typologies is that the general form (e.g. point) may reflect the "type" but the configuration of the tip is a by-product of use, either kind or intensity of use and generally varies considerably. An ideal attribute system is focused, detailed, discrete and comprehensive; it is also long. Thus, unless the assemblage is large, the cells will hold numbers so small as to be without inferential power (but see Russell 1990: 526-527 for Selevac attribute system).

Nerissa Russell (1982) and others (e.g. Lemoine 1994), lead by Semenov (1964) experimented with the formation of usewear on bone tools. Russell used her observations in the subsequent microscopic study of the bone artifacts from neolithic Selevac (1990: 522-548) which provided her with clear ideas on how they were used. Microscopic examination of the bone tools was never undertaken at Sitagroi (the assemblage is archived in Greece and still might be so studied) but stippling in the line drawings suggests various kinds of usewear.

Metapodials, especially of Caprovines and Cervus were commonly selected and on many carefully made points, such as fig. 8 from Phase III; it's clear that the epiphysis has been ground, perhaps for aesthetic reasons, or to operate more smoothly, especially with textiles. Some insight into the manufacturing process comes from the EBA Burnt House (Renfrew 1986: 190-203; Elster 1997: Pl. Vb) where a red deer metapodial (length: 30.3 cm) was recovered on the floor of the "kitchen" (fig. 21). It may be a preform because the toolmaker had already grooved it longitudinally (perhaps with a burin or a *piece éscaillée*) preparatory to splitting. A skillful worker could have produced two tools from a preform such as this and as many as four although the groove here curves uncomfortably. A comparable grooved long bone with no other working was reported from the Arene Candide cave assemblage (Maggi et al 1997: 517,528, fig. 8:12). Four more bone artifacts were recovered from the Sitagroi Burnt House including two points (not illustrated) and the long bone with chisel like end (fig. 13).

If the goal is to produce a tool quickly, production can also be as expeditious as cracking a long bone or rib with a hard stone, then selecting a splinter to be quickly shaped by grinding and smoothing (Petrequin 1975: 65). One artifact illustrates this simplified method (fig. 12); it is probably unfinished since the rough parts along the long margin of the bone were not ground and smoothed away although the tip was prepared and appears to have been used.

This broad category includes objects often classified in the field as awls/penetration tools, some heavy enough to work through rawhide or pierce materials used in mat making. The latter craft was practiced at Sitagroi since there are both single and double mat weave impressions on sherds (Adovasio and Illingworth 2001; Elster 1989:45, fig.6: b, c; Elster 2001b). Other points are much lighter and could have been used to pin up hair, fasten clothing, or as a stylus to form the incised, excised or punctuate designs found on many examples of Sitagroi pottery from various Phases (e.g., Evans 1986: 423, fig.12: 10:5; 424, fig. 12.11:1,2,5) and figurines (Gimbutas 1986: 227 ff.).

Pointed tools dominate many assemblages from prehistoric sites. At Selevac, over half of the total bone tool assemblage was pointed (Russell 1990, 524); at Obre, more than one-third (Sterud and Sterud 1974: 244); and at Arene Candide, the count of awls, points and needles reached over 70.0 percent (Maggi et al, 1997: 514, tab. 1). The problem is that taxonomic identification is either impossible or questionable. Therefore, although 42.0 percent of MN/C tools (tab. 6) were pointed (count=121), more than half of these were from unidentifiable taxa (count =73). Nevertheless, when taxa and elements are identifiable in the MN/C assemblage of pointed tools (tab. 9), metapodials are most likely to be used, first from Caprovines, followed by roe deer, red deer and deer. The tool count is smaller (tab. 10) for the EBA but Caprovine and deer metapodia are most frequently chosen. When identifiable, the EBA pointed tools are manufactured on a variety of elements from domesticated animals: tibia, ulna, and even humeri. The mean length for pointed tools for which we have identification of both taxa and element indicates that the longest are manufactured on metapodials (tabs. 9, 10). During MN/C the range is 6.0 (*Bos taurus*) to 9.6 cm (*Cervus elaphus*). The longer points are from the EBA, ranging from 5.0 cm (*Capreolus capreolus*) to 10.2 (*Cervus elaphus*).

The final example is a double point from Phase I (fig. 11); it is carefully worked and smoothed, probably on a long bone, with wear polish noted from tip to tip along left margin. The preserved length of this slim point is 11.7 cm; the fracture is at the wider end. From the line drawing, Elizabeth Barber (personal communication, November 1995) judged it to be a weaver's "pin beater", used to "beat" or push the weft tight during the weaving process. It is described as smooth and thin and would have fit easily in the hand. But there are other possibilities for its use: as an awl, a pin, a burnisher, and even to incise designs on pottery since specific shapes are so decorated in Phase I (Elster 1986: 332-335).

Elaborated pieces (figs. 7, 15-18) may not have required more time and energy to produce than the carefully modified points on metapodials or the shaft-hole antler sleeves (fig. 3), but they are certainly not expeditiously executed artifacts. The first settlers at the Sitagroi site (ca 5400 BC) were familiar with the techniques of bone elaboration as demonstrated by two artifacts, both from contexts of Phase I. The handle of a spoon was carved on a long bone (fig 18) and the fracture comes at the wider part where the indentation for the bowl has begun. Particularly fine workmanship is observable in the way the handle was carved into a grooved, smooth shape (Preserved length: 5.6 cm).

Antler				Type						
Taxon	chiselend	elaborated	flatend	miscell.	perforated	pointed	rounded	shafthole	Total	%
Red deer	9	2	10	83	2	3	9	7	125	78
Roe deer	1					3	3		7	4
Deer sp.	1		2	20			5		28	17
Total	11	2	12	103	2	6	17	7	160	99
Unident.						1			1	1
TOTAL	11	2	12	103	2	7	17	7	161	100
Percent	7	1	8	64	1	4	11	4	100	

Tab. 8 Distribution of antler and types

Phases	I, II, III			Element			
Domestic	humerus	metapodium	rib	tibia	ulna	Total	%
Cattle		1 (6.0)				1	2
Sheep/goat	2 (3.1)	25 (4.3)		5 (4.3)	3 (3.9)	35	66
Total	2	26		5	3	36	68
Wild	humerus	metapodium	rib	tibia	ulna	Total	%
Red deer		3 (9.6)				3	6
Roe deer		6 (6.2)				6	11
Deer sp.		3 (9.3)				3	6
Total		12				12	23
Unident.		1	4			5	9
TOTAL	2	39	4	5	3	53	100
Percent	3	74	8	9	6	100	

Tab. 9 Distribution of pointed tools, domesicated or wild taxa and elements for the Middle Neolithic/ Chalcolithic

Phases	I, II, III			Element			
Domestic	humerus	metapodium	rib	tibia	ulna	Total	%
Sheep/goat		4 (7.2)		2 (5.8)	1 (5.8)	6	32
Pig	1 (7.3)					1	5
Total	1	4		2	1	7	37
Wild	humerus	metapodium	rib	tibia	ulna	Total	%
Red deer		4 (10.2)				4	21
Roe deer		1 (5.0)				1	5
Deer sp.		4 (7.2)		1 (4.3)		5	26
Total		9		1		10	52
Unident.		1 (11.3)	1 (11.0)			2	11
TOTAL	1	14	1	3	1	19	100
Percent	4	73	4	15	4	100	

Tab. 10 Distribution of pointed tools, domesicated or wild taxa and elements for the Early Bronze Age. Average tool lengths (mm) are parenthesized

The second is a narrowed, rounded, polished rod (fig. 17) with matching sets of 4 circling grooves at each end of the artifact. Elizabeth Barber (personal communication, November 1995) has suggested that it would have been useful as a net mending tool since the string could be tied in one of the grooves and the artifact would fit easily in hand as you maneuvered through the net. Janet Spector (1989: 396-401) provided me with an alternate interpretation with her report of an engraved antler awl handle, uncovered at her excavation of an historic site in the American Midwest. She learned that these awls were Native American women's tools and that the antler handles were engraved periodically to record accomplishments as the owner grew from girl to womanhood. The Sitagroi artifact, with its groovings might well have signified something as important to its owner, although I am not aware of analogous ethnographic literature pertaining to Greece and/or the Balkans. However, A. Benac considered similarly incised, engraved bone artifacts from Obre II as jewelry (1973: 104, Pl. XXIV: 3,4,5,7).

The forms from later phases are sometimes unique and sometimes repeat types from earlier periods. For example, animal teeth, especially from wild pig are frequently perforated and were probably suspended as pendants but I do not consider these as elaborated pieces. However, the Phase III "plaques", not unusual in southeast European sites of this time period, are so tabulated. These flattish, rectangular artifacts (fig. 15) were probably formed on cattle ribs, with sets of perforations along the narrower end, allowing them to be sewn on textiles, bound to leather, or strung with a multiple cord (or leather thong). It has also been suggested that they were used for card or tablet weaving which requires at least perforations at corners (Barber 1991: 534; Russell 1990: 534;). Perforations at opposite corners were fractured, probably during use. These are comparable to artifacts for example, from Vinča sites (Bačkalov 1979: T. XLV: 16.5; Russell 1990: 534) and Arene Candide (Maggi et al 1997: 516, fig. 5-9).

Another example of extensive work on an artifact is the Phase III split antler beam (fig. 7). From the illustration, N. Russell identified it as a rough out, a thinned, but unfinished broken spoon or ladle. Since it represents considerable reduction and shaping, Russell's opinion was that it might have been prepared for use in ritual serving. If so, it carries a dimension beyond utility and, along with bone jewelry, offers information about the symbolic side of Sitagroi life.

Other Phase III artifacts were elaborated with notches, as is a somewhat curved broken handle, probably manufactured on a split rib (fig. 16) with three notches on both margins, and one on the preserved end. It was reduced by cutting, carving, grinding, and smoothing (Length: 5.5 cm, Width: 1.4 cm). There appears to be widening at the break so this may be the decorative handle of a spoon and is comparable to those illustrated from Vinča (Bačkalov 1979: T. XXVII: 12).

In summary, Sitagroi bone tool manufacturing must have been a task for anyone and everyone. Some carvers–women, men, young or old–took the time to elaborate the shapes beyond the dictates of utility, as demonstrated in the handles (figs. 7, 16, 18), and the rod (fig. 17). This speaks for an aesthetic sense and also a symbolic vocabulary, qualities of Sitagroi life reflected in other aspects of the material culture and like these bone artifacts, deserving of further study. My work for this paper was different from a library research project because I was familiar with the artifacts and the documentation, on which I relied heavily, using it with both respect and caution. The Sitagroi assemblage had context, chronology, documentation and the inevitable ambiguity of archaeological data. It is a potentially rich trove for future research.

Notes

[1] Alice Choyke was a mythical person, until we met at the EAA in Gothenburg in 1998. Although I could not attend the Worked Bone Research Group Meeting, Budapest, Aug 31-Sept 3, 1999, I am pleased that this paper is included and thank Alice for her most useful comments. I very much appreciate the guidance of Nerissa Russell (Cornell University) and from the Cotsen Institute of Archaeology, UCLA: Judith Rasson and Tom Wake and the members of the Palaeozoology Laboratory which he directs. All errors are mine alone.

[2] Shell is treated separately by N. Schackleton, M. Nikolaidou, and M. Miller in Excavations at Sitagroi, vol. 2, 2001.

References

Adovasio, J. & Illingworth, J. 2001. forthcoming, Basketry and Textile Impressions from Sitagroi. In *Excavations at Sitagroi: A Prehistoric Village in Northeast Greece Vol. 2*, eds. E. S. Elster C. Renfrew. Monumenta Archaeologica 13. University of California - Los Angeles, Institute of Archaeology, Los Angeles.

Bačkalov, A. 1979. *Predmeti od kosti i roga u preneolitu Srbije* (Bone and Antler Objects in the Pre-neolithic and Neolithic of Serbia). Fontes Archeologiae Jugoslaviae Tome II. Savez Arheoloških Druztava Jugoslavije, Beograd.

Barber, E. 1991. *Prehistoric Textiles*. Princeton University Press, Princeton.

Benac, A. 1973. *Obre I and II*. Wissenschaftliche Mitteilungen des Bosnisch-Herzegowinischen Landesmuseums, Band IV, Heft A, Sarajevo.

Bökönyi, S. 1986. Faunal Remains. In *Excavations at Sitagroi: A Prehistoric Village in Northeast Greece Vol. 1*, eds. C. Renfrew, M. Gimbutas & E. S. Elster. Monumenta Archaeologica 13. University of California - Los Angeles, Institute of Archaeology, Los Angeles, pp. 63-132.

Choyke, A. M. 1997. The bone tool manufacturing continuum. *Anthropozoologica* 25/26, pp. 65-72.

Choyke, A. M. 1998. Bronze Age red deer: case studies from the Great Hungarian Plain. In *Man and the Animal World: Studies in Archaeozoology, Archaeology, Anthropology, and Palaeolinguistics in memoriam Sándor Bökönyi*, eds. P. Anreiter, L. Bartosiewicz, E. Jerem, & W. Meid. Archaeolingua, Budapest, pp. 157-178.

Clark, R. M. 1975. A calibration curve for radiocarbon dates. *Antiquity* 49, pp. 251-266.

Elster, E. S. 1986. Tripods, Plastic Vessels, and Stands: A Fragmentary Collection of Social Ceramics. In *Excavations at Sitagroi: A Prehistoric Village in Northeast Greece Vol. 1*, eds. C. Renfrew, M. Gimbutas & E. S. Elster. Monumenta Archaeologica 13. University of California - Los Angeles, Institute of Archaeology, Los Angeles, 303-344.

Elster, E. S. 1989. An Archaeologist's perspective on prehistoric textile production: the case of Sitagroi. in Η Δραμα και η Περιοχη τησ Ιστορια και Πολιτισμοσ, Drama, Demos, pp. 29-46.

Elster, E. S. 1997. Construction and Use of the Early Bronze Age Burnt House at Sitagroi: Craft and Technology. In *TEXNH: Craftsmen, Craftswomen and Craftmanship in the Aegean Bronze Age; Proceedings of the 6th International Aegean Conference*, eds. R. Laffineur & P. P. Betancourt, pp. 19-35.

Elster, E. S. 2001a. forthcoming, The Bone Tools. In *Excavations at Sitagroi: A Prehistoric Village in Northeast Greece Vol. 2*, eds. E. S. Elster & C. Renfrew. Monumenta Archaeologica. University of California - Los Angeles, Institute of Archaeology, Los Angeles.

Elster, e. S. 2001b. forthcoming, Tools for Spinning, Weaving, and Mat Making. In *Excavations at Sitagroi: A Prehistoric Village in Northeast Greece Vol. 2*, eds. E. S. Elster & C. Renfrew. Monumenta Archaeologica. University of California - Los Angeles, Institute of Archaeology, Los Angeles.

Evans, R. K. 1986. The Pottery of Phase III. In *Excavations at Sitagroi: A Prehistoric Village in Northeast Greece Vol. 1*, eds. C. Renfrew, M. Gimbutas & E. S. Elster. Monumenta Archaeologica 13. University of California - Los Angeles, Institute of Archaeology, Los Angeles, 393-428.

Gimbutas, M. 1986. Mythical Imagery of Sitagroi Society. In *Excavations at Sitagroi: A Prehistoric Village in Northeast Greece Vol. 1*, eds. C. Renfrew, M. Gimbutas & E. S. Elster. Monumenta Archaeologica 13. University of California - Los Angeles, Institute of Archaeology, Los Angeles, 225-301.

Hiller, S. & Nikolov V. eds. 1997. *Karanovo: Die Ausgrabungen im Südsektor 1984-1992*, Verlag Ferdinand Berger & Söhne, Horn/Wien, Salzburg-Sofia.

Larje, R. 1987. Animal Bones. In *Paradeisos, A Late Neolithic Settlement in Aegean Thrace*, ed. P. Hellstrom, Medelhavsmuseet, Memior 7, Stockholm.

LeMoine, G. M. 1994. Use Wear on Bone and Antler Tools from the Mackenzie Delta, Northwest Territories. *American Antiquity* 59/2, pp. 316-333.

Lyneis, M. M. 1988. Antler and Bone artifacts from Divostin. In *Divostin and the Neolithic of Central Serbia*, eds. A. McPherron & D. Srejovi, Ethnology Monograph 10, Department of Anthropology, University of Pittsburgh, Pittsburgh, pp. 301-323.

Maggi, R. Starnini, E. & Voytek, B. 1997. The Bone Tools from Arene Candide: Bernabo Brea Excavations. In *Arene Candide: A Functional and Environmental Assessment of the Holocene Sequence* (Excavations Bernabo Brea-Cardini 1940-50), ed. R. Maggi, "il Calamo" Rome.

Pétrequin, P. 1993. North Wind, South Wind: Neolithic technical choices in the Jura Mountains, 3700-2400 BC. In *Technological Choices: Transformation in Material Cultures Since the Neolithic*, ed. Pierre Lemonnier, Routledge, London - New York: pp. 36-76.

Rappaport, R. A. 1968. *Pigs for the Ancestors*, Yale University Press, New Haven and London.

Renfrew, C. 1970. The Burnt House at Sitagroi. *Antiquity* 44: 131-134.

Renfrew, C. 1986. The Excavated Areas. In *Excavations at Sitagroi: A Prehistoric Village in Northeast Greece Vol. 1*, eds. C. Renfrew, M. Gimbutas & E. S. Elster. Monumenta Archaeologica 13. University of California - Los Angeles, Institute of Archaeology, Los Angeles, 175-222.

Renfrew, C. M. Gimbutas, & E. S. Elster, eds. 1986. *Excavations at Sitagroi: A Prehistoric Village in Northeast Greece* vol. 1, Monumenta Archaeologica 13. University of California - Los Angeles, Institute of Archaeology, Los Angeles.

Russell, N. 1982. *Experimentation as an Aid to the Study of Manufacture and Utilization Patterns of Bone Artifacts*. Paper presented at 47th Annual Meeting of the Society for American Archaeology, Minneapolis.

Russell, N. 1990. The Bone Tools. In *Selevac: A Neolithic Village in Yugoslavia*, eds. R. Tringham & D. Krstic. Monumenta Archaeologica 15, University of California - Los Angeles, Institute of Archaeology, Los Angeles, pp. 521-548.

Sackett, J. R. 1966. Quantitative Anaylsis of Upper Paleolithic Stone Tools. *American Anthropologist* 68, ser. 2, pt. 2, pp. 356-394.

Séfériadés, M. 1992. L'os et le bois de cervide. Dikili Tash: Village Prehistorique de Macedoine Orientale 1. *Bulletin de Correspondance Hellenique, Supplement* XXIV, Ecole Française d 'Athenes, Athenes, pp. 99-112.

Semenov, S. A. 1964. *Prehistoric Technology*. Coney, Adams and Mackay, London.

Spector, J. D. 1991. What this awl means: toward a feminist archaeology. In *Engendering Archaeology: Women and Prehistory*, eds. J. M. Gero & M. W. Conkey, Basil Blackwell Ltd., Oxford, pp. 388-406.

Sterud, E. & A. K. Sterud 1974. The Worked Bone. In *Obre I and II*, ed. M. Gimbutas. Wissenschaftliche Mitteilungen des Bosnisch-Herzegowinischen Landesmuseums, Band IV, Heft A, Sarajevo, pp. 237-250.

Tringham, R. 1990. Cultural Transformation in the Neolithic and Eneolithic of Southeast Europe. In *Selevac: A Neolithic Village in Yugoslavia*, eds. R. Tringham & D. Krstic. Monumenta Archaeologica 15, University of California - Los Angeles, Institute of Archaeology, Los Angeles, pp. 521-548.

Yannouli, E. 1994. *Aspects of Animal Use in Prehistoric Macedonia, Northern Greece*. Unpublished dissertation, Department of Archaeology, University of Cambridge.

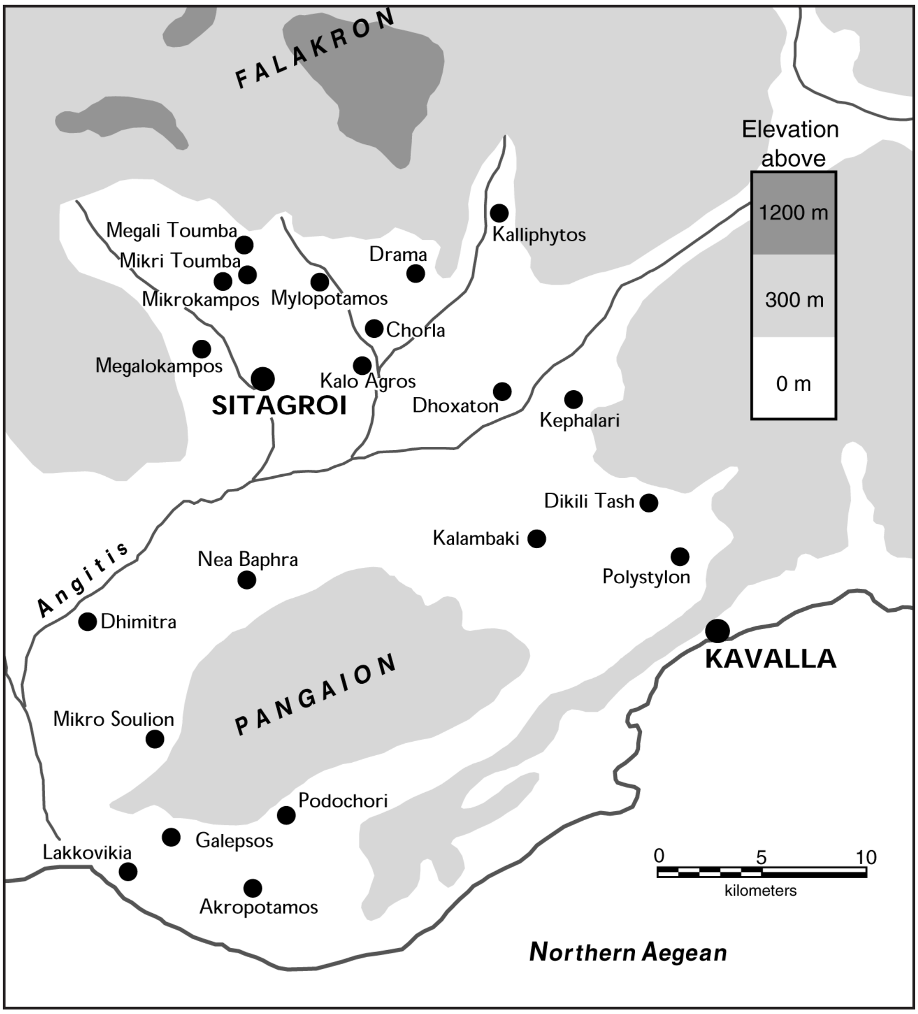

Fig. 1 Map of the Drama plain; sites contemporary with Sitagroi

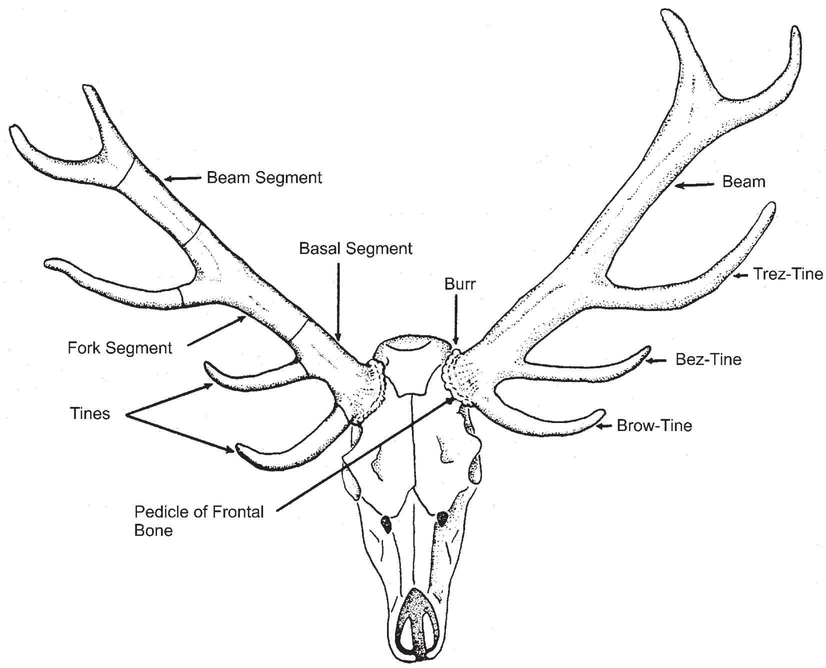

Fig. 2 Antler anatomy, Cervus elaphus (after Lyneis 1988, 302)

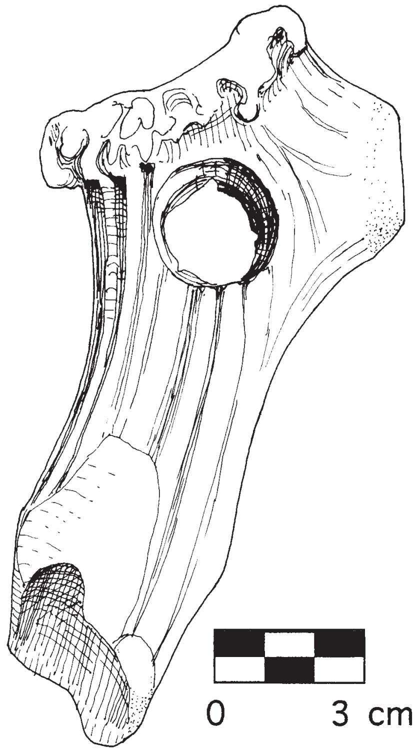

Fig. 3 Antler beam with rosette, tine brow cut, round socket, hollowed end (SF 521 MM12, III)

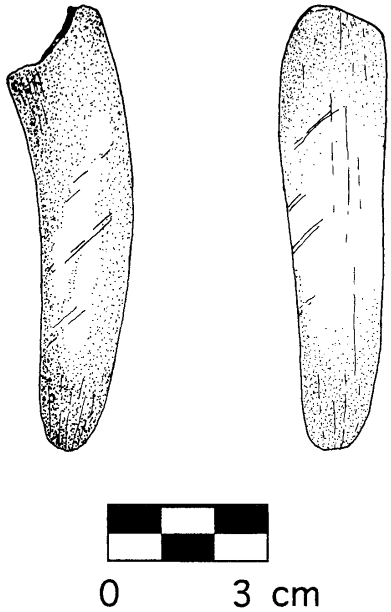

Fig. 4 Antler tine, red deer, with rounded end (SF 111 JL11, I)

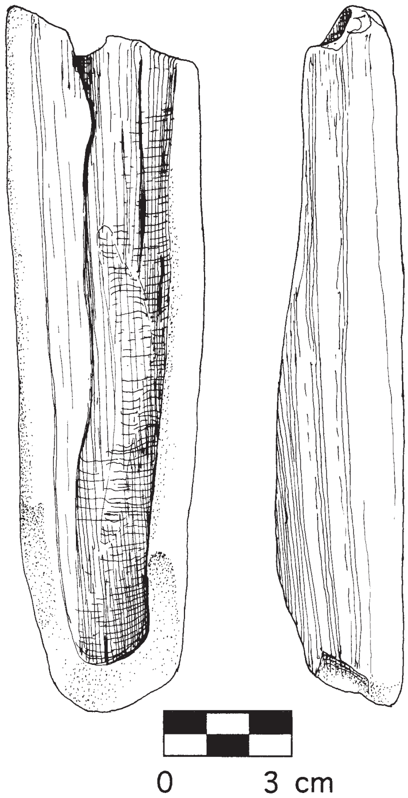

Fig. 5 Split antler beam, inner core removed, with chisel or bevel shaped end (SF 5405 ZA57, II)

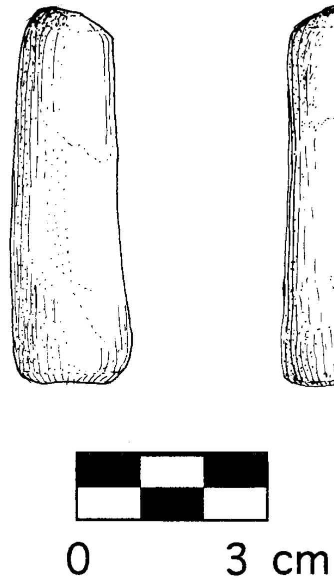

Fig. 6 Antler section, flattened end, "punch" (?), "cut & break" (SF 447 KM13, II)

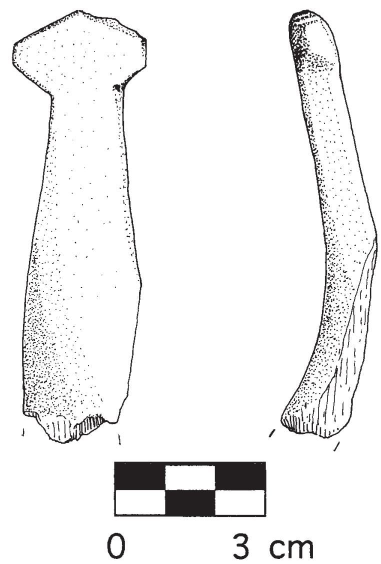

Fig. 7 Split antler, roughed-out form, broken (SF 4848 MM12, III)

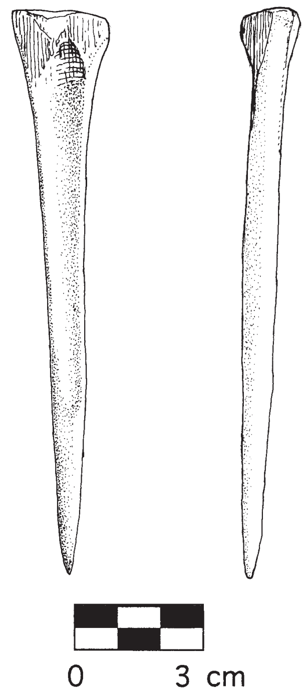

Fig. 8 Long bone, split and tapered, with ground epiphysis and pointed end (SF 1194 MM12, III)

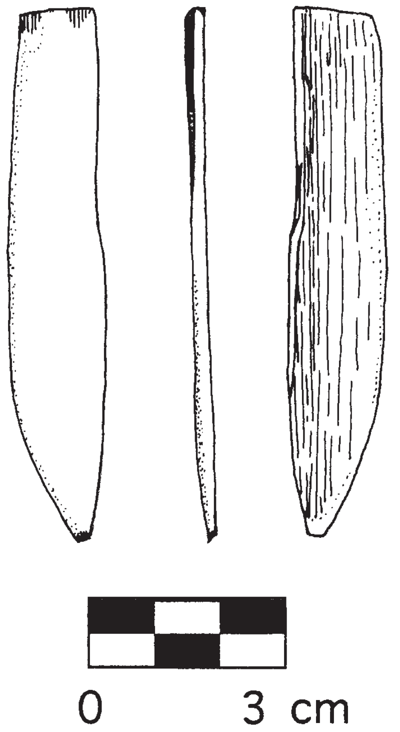

Fig. 9 Split rib, one end pointed, opposite cut transversally (SF 3776 Klb121, II)

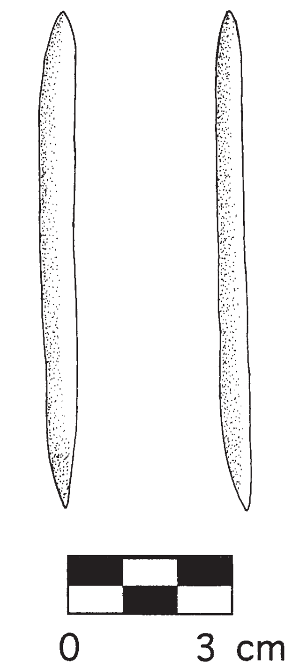

Fig. 10 Double ended point (SF 1528 ZA32, IV)

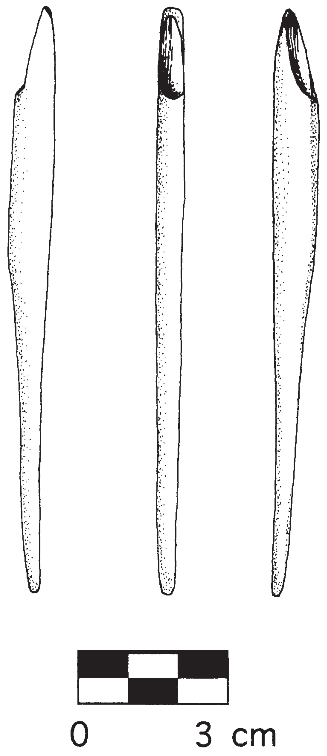

Fig. 11 Point, one end fractured (SF 4112 Klb137, I)

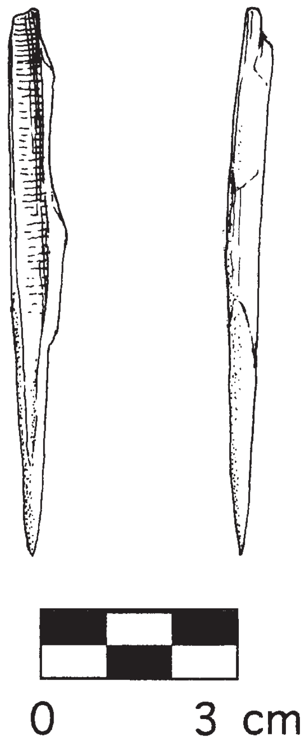

Fig. 12 Unfinished point (SF 1081 QN8, V)

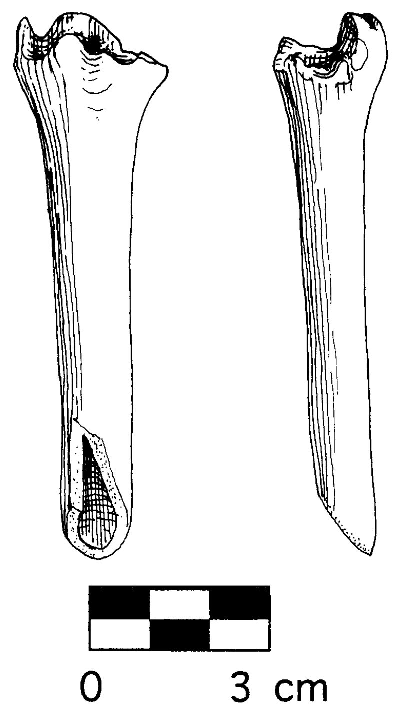

Fig. 13 Distal tibia with chisel or bevel shaped end (from the Burnt House, SF 4581 PO160, Va)

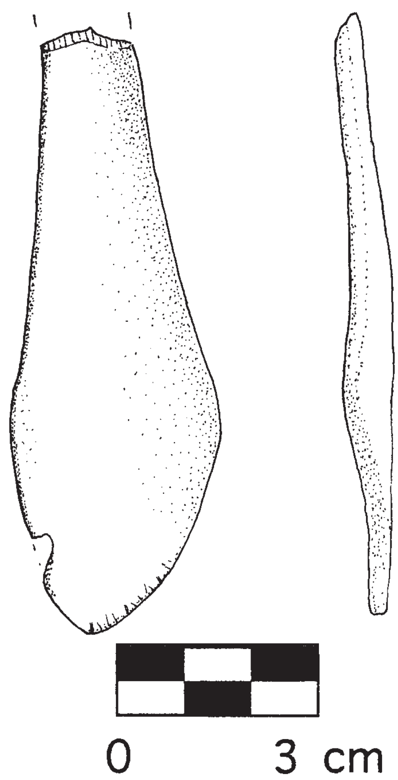

Fig. 14 Rib (?) split, shaped and smoothed, spatula and/or polisher (SF 501 MM16, III)

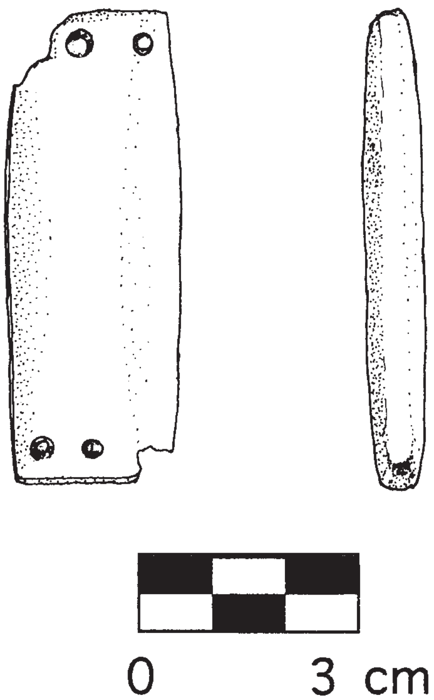

Fig. 15 Rib (?), perforated rectangular piece, "plaque" (SF 834 MM38, III)

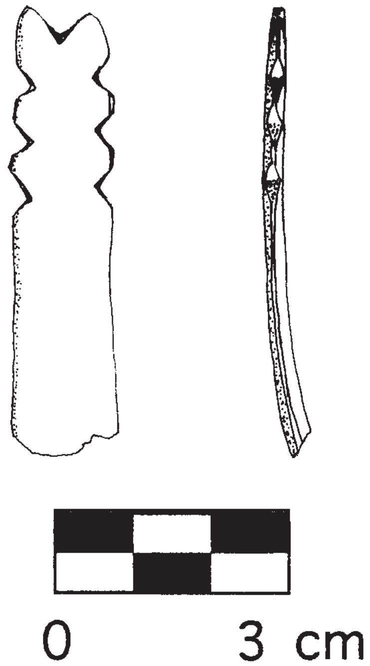

Fig. 16 Split rib (?), elaborated with three notches each side, and single notch at top (SF 3449 MMa60, III)

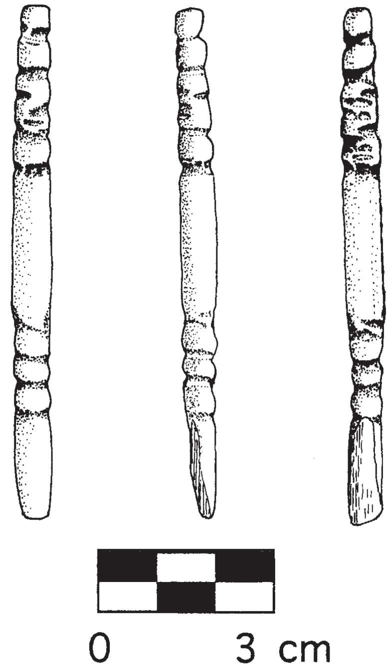

Fig. 17 Rod shape, smoothed and elaborated with circling grooves (SF 3706 Klb126, I)

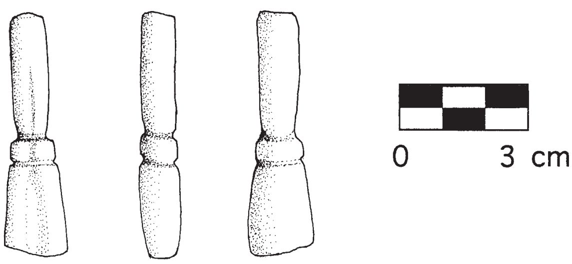

Fig. 18 Long bone (?), handle (?), elaborately shaped and grooved (SF 106 IL8, I)

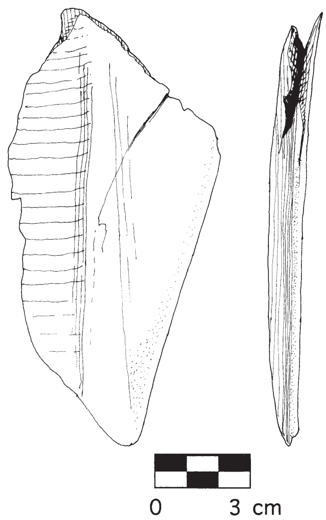

Fig. 19 Scapula, right shoulder with ground spine and rounded tip (SF 4660 Zht10, IV)

Fig. 20 Ulna, large cattle or red deer, wear at rounded point (SF 4693 ZG31, III)

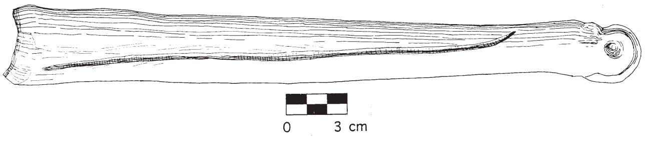

Fig. 21 Metatarsus, red deer, grooved, a preform preparatory to splitting (from the Burnt House, SF 4567 PO159, Va)