

CRAFTING BONE – SKELETAL TECHNOLOGIES THROUGH TIME AND SPACE

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

Editors

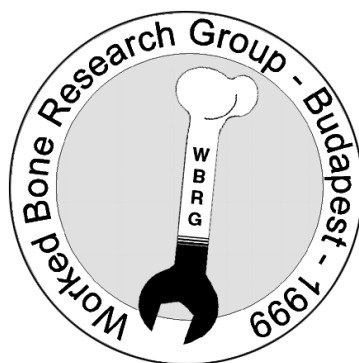
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Table of Contents

Introduction	III-IV
 General Theory	
Genevieve LeMoine – <i>Skeletal Technology in Context: An Optimistic Overview</i>	1
 Raw Material Exploitation	
Lyuba Smirnova – <i>Utilization of Rare Bone Materials in Medieval Novgorod</i>	9
Liina Maldre – <i>Bone and Antler Artefacts from Otepää Hill-fort</i>	19
Sabine Deschler-Erb – <i>Do-it-yourself Manufacturing of Bone and Antler in Two Villas in Roman Switzerland</i>	31
Rosalia Christidou – <i>Study of Bone Tools at Three Late/Final Neolithic Sites from Northern Greece</i>	41
 Manufacturing Technology	
Jörg Schibler – <i>Experimental Production of Neolithic Bone and Antler Tools</i>	49
Daniella Ciugudean – <i>Workshops and Manufacturing Techniques at Apulum (AD 2nd-3rd Century)</i>	61
Kitty F. Emery – <i>The Economics of Bone Artifact Production in the Ancient Maya Lowlands</i>	73
Karlheinz Steppan – <i>Worked Shoulder Blades: Technotypological Analysis of Neolithic Bone Tools From Southwest Germany</i>	85
Noëlle Provenzano – <i>Worked Bone Assemblages from Northern Italian Terramare: A Technological Approach</i>	93
Aline Averbouh – <i>Methodological Specifics of the Techno-Economic Analysis of Worked Bone and Antler: Mental Refitting and Methods of Application</i>	111
 Function	
Mária Bíró – <i>A Round Bone Box Lid with a Mythological Representation</i>	123
Cornelia Becker – <i>Bone Points - No Longer a Mystery? Evidence from the Slavic Urban Fortification of Berlin-Spandau</i>	129
Mickle G. Zhilin – <i>Technology of the Manufacture of Mesolithic Bone and Antler Daggers on Upper Volga</i>	149
Tina Tuohy – <i>Bone and Antler Working on the Iron Age Sites of Glastonbury and Meare in Britain</i>	157
Gitte Jensen – <i>Macro Wear Patterns on Danish Late Mesolithic Antler Axes</i>	165
Yekaterina Antipina – <i>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</i>	171
Andreas Northe – <i>Notched Implements made of Scapulae - Still a Problem</i>	179
Janet Griffiths – <i>Bone Tools from Los Pozos</i>	185
Sandra L. Olsen – <i>The Importance of Thong-Smoothers at Botai, Kazakhstan</i>	197
Janet Griffiths and Clive Bonsall – <i>Experimental Determination of the Function of Antler and Bone 'Bevel-Ended Tools' from Prehistoric Shell Middens in Western Scotland</i>	207
 Social Context	
Isabelle Sidéra – <i>Domestic and Funerary Bone, Antler and Tooth Objects in the Neolithic of Western Europe: a Comparison</i>	221
George Nash – <i>Altered States of Consciousness and the Afterlife: A Reappraisal on a Decorated Bone Piece from Ryemarksgaard, Central Zealand, Denmark</i>	231
Nerissa Russell – <i>The Social Life of Bone: A Preliminary Assessment of Bone Tool Manufacture and Discard at Çatalhöyük</i>	241
Alice M. Choyke – <i>Late Neolithic Red Deer Canine Beads and Their Imitations</i>	251
Colleen Batey – <i>Viking and Late Norse Combs in Scotland: An Update</i>	267
Nerissa Russell – <i>Neolithic Relations of Production: Insights from the Bone Tool Industry</i>	271

Special Assemblages

Péter Gróf and Dániel Gróh – <i>The Remains of Medieval Bone Carvings from Visegrád</i>	281
László Bartosiewicz – <i>Roman Period Equid Ilium Implement from Pannonia Superior (NW Hungary)</i>	287
E.E. Bulten and Anneke Clason – <i>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</i>	297
Heidi Luik – <i>Bone Combs from Medieval Tallinn, from the Excavations in Sauna Street</i>	321
Steven R. James – <i>Prehistoric Hohocam Bone Artifacts from Southern Arizona: Craft Specialization, Status and Gender</i>	331
Arthur MacGregor and Ailsa Mainman – <i>The Bone and Antler Industry in Anglo-Scandinavian York: the Evidence from Coppergate</i>	343
Ernestine Elster – <i>Middle Neolithic to Early Bronze Age Bone Tools from Sitagroi, Greece</i>	355
Ülle Tamla and Liina Maldre – <i>Artefacts of Bone, Antler and Canine Teeth among the Archaeological Finds from the Hill-Fort of Varbola</i>	371
Kordula Gostenčnik – <i>Pre- and Early Roman Bone and Antler Manufacturing in Kärnten, Austria</i>	383
Index of Authors	399



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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 in 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 commitment 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 traditions 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 sur l’Industrie de l’Os Préhistorique*” headed by 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 methodological points of view. One striking example of this can be seen in 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 concentrate 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 comparative 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.

WORKED BONE ASSEMBLAGES FROM NORTHERN ITALIAN TERRAMARES: A TECHNOLOGICAL APPROACH

Noëlle Provenzano

Abstract: Terramare represent a significant moment in the Italian Bronze Age. Hard animal material products show by their number and their quality, that they are a significant factor in economic activity. These industries (by their quantity and their good state of preservation) offer a sufficiently vast and reliable corpus to undertake not only typological studies, but also technological and functional analyses. The typological framework is particularly huge, and if we encounter there a number of objects known through all prehistory, we may also distinguish typical products of the period and the geographical area. The deer antler is particularly appreciated and the supports in bone are chosen in a very selective way in food waste. We may observe large differences between the raw material used and the fauna consumed. Most of the studied objects are composed of "technical pieces" which indicate an *in situ* working of the osseous material and which are extremely useful for reading the marks of manufacture, as well as for the reconstitution of the operational chains and the study of the economic management of the raw materials. Whereas the products of early Bronze Age still pertain technologically to a strong Neolithic tradition, the terramaricolas craftsmen adopt different methods where cutting up is done primarily by fracturing and notching, and shaping by abrasion and especially by decortication. In addition, during the transition to the middle/late Bronze Age, the use of the bronze saw is duly attested if just at its beginnings. The analysis of these terramaricole products shows that hard animal material played an important role in the technical equipment of these prehistoric people, who used them in many domestic tasks.

Keywords: Italy, Middle Bronze Age, Terramare culture, raw material selection, manufacture

Résumé: L'industrie osseuse des terramare d'Italie septentrionale: approche typologique et technologique. Les Terramare représentent un important moment de l'Age du Bronze italien. Les productions en matière dure animale démontrent par leur nombre et leur qualité, qu'elles sont un acteur important de l'activité économique. Elles offrent un corpus suffisamment vaste et fiable pour permettre d'entreprendre non seulement des études typologiques, mais également technologiques et tracéologiques. Le cadre typologique est particulièrement vaste, et si on y rencontre nombre d'objets connus à travers toute la préhistoire, on y distingue aussi des productions typiques de la période et de la zone géographique. Le bois de cerf est particulièrement prisé et les supports en os sont prélevés de manière très sélective dans les déchets alimentaires. On observe par ailleurs un fort décalage entre les matières premières utilisées et la faune consommée dans le site. Une grande partie du matériel étudié est composé de pièces techniques qui indiquent un travail *in situ* des matières osseuses et qui sont extrêmement utiles pour la lecture des stigmates de fabrication, mais aussi pour la reconstitution des chaînes opératoires et l'étude de la gestion économique des matières premières. Alors que les productions du Bronze ancien sont encore technologiquement de forte tradition néolithique, les artisans terramaricoles adoptent des méthodes différentes où le débitage se fait essentiellement par fracturation et entaillage, et le façonnage par abrasion et surtout par décortication. Enfin, à la transition Bronze moyen/Bronze récent apparaît timidement l'utilisation de la scie en bronze. L'analyse de ces productions démontre que les matières dures animales prennent une grande part dans l'équipement technique des groupes terramaricoles, et qu'elles interviennent dans un grand nombre d'activités domestiques.

Mots-clés: Italie, Bronze moyen, Terramare, sélection matières premières, technologie osseuse

Zusammenfassung: Die Terramarekultur stellt eine entscheidende Phase in der Bronzezeit Italiens dar. Gemessen an Umfang und Qualität war die Verarbeitung von Tierknochen ein bedeutenden Faktor im Ablauf wirtschaftlicher Prozesse. Durch die große Zahl und gute Erhaltung der Funde wird die Möglichkeit nicht nur für typologische, sondern auch für technologische und funktionale Studien geboten. Wenn man die Masse aller in der Vorgeschichte bekannten Artefakte bedenkt, so ist der typologische Rahmen umfangreich und erlaubt gleichzeitig, typische Herstellungsmodalitäten für diese Periode und in dieser Region zu erkennen. Rothirschgeweih wurde bevorzugt verarbeitet; das Rohmaterial Knochen wurde sehr gezielt aus Schlachtabfällen gewählt. Zwischen diesen und dem verwendeten Rohmaterial lassen sich große Diskrepanzen feststellen. Die meisten der hier untersuchten Artefakte wurden gezielt produziert, eine lokale Verarbeitung der Knochen ist belegt und die Funde liefern zudem nicht nur für die Ausdeutung verschiedener Arbeitsschritte sehr wertvolle Hinweise, sondern auch für die Rekonstruktion der sog. chaîne opératoire und die Verteilung des Rohmaterials. Während die Produktion in der Frühbronzezeit noch stark den neolithischen Traditionen verhaftet ist, haben sich die Handwerker aus der Terramarekultur bereits verschiedene Arbeitsweisen angeeignet. Dies gilt für die Rohzerlegung durch Einkerbungen und Brechen, das Vorformen durch Abrieb und vor allem das Entfernen des Kortex. Zusätzlich kann während der Übergangsphase von der Mittleren zur Späten Bronzezeit die Verwendung von Bronzesägen belegt werden. Die Analyse der terramarezeitlichen Verarbeitung von Tierknochenmaterial hat gezeigt, daß Tierknochenmaterial ein wesentlicher Bestandteil des Geräteinventars des prähistorischen Menschen einnimmt und daß es in vieler Hinsicht für häusliche Verrichtungen unverzichtbar war.

Schlüsselworte: Italien, Mittel Bronzezeit, Terramarekultur, Auswahl von Rohmaterial, Herstellungsprozess

The terramaricole cultural phenomenon, which lasted more than five centuries, is mainly found in the Central-western Po Valley, including south of the Po river, the Emilian territory located between the rivers Ardo and Panaro and limited on the south by the Appennins. The terramaricoles can be found to the north of the Po, in the low Lombard and Veronese valleys. In the early Bronze Age, the Po Valley was almost deserted. The first terramaricole settlements begin at the beginning of the following period (15thc. BC), but it is above all in the midst of the middle Bronze, i.e. starting from 15thc., that the Po valley sees a strong demographic explosion. Between 16th and 12thc. BC (middle Bronze Age to late Bronze Age) the territory is intensively occupied, and a site can be found every 25 km (fig. 1). It is not certain that the traditional type of terramaricole settlement, of simple dwellings in a large quadrangle surrounded by ramparts and a ditch connected to a river, already existed at the time of the first villages. This model on the other hand, is well established from the very beginning of the middle Bronze (15thc. BC), when occupations are very standardized but of reduced size (1 to 2 ha). However, starting from the 14thc. BC they diversify and increase in size (generally to around 10 ha, but as much as 20 ha). The hill and valley zones of the Appennine valleys contain slightly different settlements, located at higher altitudes in positions of defensive control (Aspes *et al.* 1992, Bernabò Brea *et al.* 1997a). At the beginning of the 12thc., although the real causes are not well known, terramaricole settlements are abandoned and the Po plain is deserted again throughout the final Bronze Age up to the Iron Age (Bernabò Brea 1997).

If ceramic and metal products are abundantly represented in terramaricole records, lithic industries are poor and not very varied, the objects made from animal hard materials (bone, teeth and antler) show by their number and quality, that they played an important role in economic activities. Protected by very favourable preservation conditions, these industries not only offer a sufficiently large and reliable corpus for typological studies, but technological and traceological research as well. On the other hand, the fact that most of these excavations are old means that there are significant gaps in the stratigraphic data, making it difficult to place these artefacts in a precise chronological framework.

Abundant and varied records

Without doubt, because of the richness of Bronze Age objects and metal artefacts in particular, only the most spectacular of the worked osseous material is well known. In fact, however, these industries present great typological variety, comprising both typical prehistoric artefacts as well as objects more characteristic of the Bronze Age or specific to the Terramaricole Culture; objects which can be extremely specialised or more general-purpose and which were used in many spheres of activity.

For this study, more than 3000 artefacts were analysed. These came from about fifty terramaricoles distributed south of the Po

river between Piacenza and Bologna. The whole of the osseous assemblages was taken into account, completed objects or partially completed specimens, off-cuts, blocks of raw material or simple fragments with traces of anthropogenic intervention. In any case, nearly a quarter of the studied artefacts is composed as of these “technical pieces” which are extremely useful for reading marks of manufacture, but also for the reconstitution of the “*schéma opératoire*” and the study of the economic management of raw materials.

Our intention is not to present here all the objects from terramaricoles, which would be long and tedious. For the purposes of this study, we will only present an overall view and an approach to the characteristic elements. Different publications provide an overall view of the typology of the osseous industries present in the palafittico-terramaricole area. (Belemmi *et al.* 1997, Bernabò Brea *et al.* 1997 b-d, Mangani 1997, Mutti 1993, Mutti *et al.* 1988, Provenzano 1997 a-c & in press., Salzani 1991, 1996 & 1997, Salzani & Chelidonio 1992.)

The classification of bone and antler artefacts

This extremely varied industry can be divided into seven chief groups (fig. 2-3).

- *Perforated artefacts*: the common feature of this group is the presence of one or several perforations which constitute, in fact, the real active part of the object. One can basically distinguish three sub-groups formed by large perforated artefacts, harness elements and perforated bones. The first are largely unmodified segments of antler which have one or more perforations of variable sizes in them. Their actual function is not always very clear, and it seems that they may be only one element of a more complex unit, composed of various parts which are not necessarily made from this same raw material. The second group is mainly represented by bridle cheek pieces. They do occur in very great numbers, but they are well attested. Their typology is extremely varied and they are sometimes decorated. Lastly, perforated bones constitute a sub-group of objects mostly made from diaphyses and ribs, with one or more drilled perforations. These numerous objects are all fragmented and it is rather difficult to guess their function, although some can be compared to the handle of a dagger.

- *Bevelled artefacts*: this group includes objects whose working end is bevelled. One sub-group is composed of large objects made from red deer antler beam or large perforated tines. These objects are usually considered to have been used in agricultural work. A second sub-group of tools are made of bone or antler with smaller distal edges. Some of them are undeniably chisels while others are spatulae and a certain number seems to have been used in various other activities. If the artefacts in the first sub-group are comparatively numerous, those in the second sub-group are extremely common, in particular, spatulae.

- *Pointed artefacts*: this large group contains a great variety of objects where the working end has been sharpened. It can be subdivided into three sub-groups: the first is composed of large tools made either from antler or long bones (mostly split metapodials and the ulnae of deer and cattle); the second includes small pointed objects, rather common throughout prehistory (needles, awls, double points). All these objects are completely worked and often made from splinters. The third sub-group includes the projectile points (very common and quite varied from simple pyramidal, typical of the beginning of the terramaricole period, to arrowheads with 2, 3 or even 4 barbs) and spearheads. These weapons are generally made of antler.

- *Receptacles*: this group is rather heterogeneous. These are objects whose active part in fact consists of a cavity intended to hold a tool or an object. These are primarily handles for bronze awls or chisels, very common and typologically well defined and, in addition, often decorated. This group also comprises small boxes made of large herbivore long bones (horse and cattle) or antler beam, hollowed out and with many small drilled perforations intended to fix the lid or base of the box in place (Bernabò Brea *et al.* 1997c fig. 189.15; Provenzano 1997c fig. 295.17, 19).

- *Ornaments*: this group is comprised of a particularly varied number of types, most very neat and decorated. The most frequently encountered types are wheel-shaped pin-heads (full or with rays), *alamares*, buttons, pins and tooth and antler pendants. In this group there is one particular type of small object: the combs. These are almost always made from antler (Provenzano 1991). Throughout the period, they are very well made and ornamented. At the beginning of the middle Bronze Age, they become utility objects, most probably used in weaving (some of them are even extremely worn). However, a change in function can be observed at the turn of the middle to late Bronze Ages. It appears that at that point they become simply ornamental objects displaying no use wear. Parallel to this change of status are changes in techniques of manufacture, in particular in the working of the comb teeth (Provenzano 1997a).

- *Technical elements*: Technical elements include bones with marks of manufacturing on them from all stages in the production process, up to but not including, completed tools. Examples are supports, off-cuts, half-finished tools, tools spoiled during manufacture and various debitage.

- *Various*: last but not least is the inescapable group of “miscellaneous” objects either too fragmented to be identifiable or objects with very special functions, represented by only one or two specimens such as the large antler disc from Castione or the stool from Montale (Provenzano 1997c fig. 296.33 and 297.15).

Raw material and faunal exploitation

In the terramaricole culture, animal hard materials prove to be

a significant source of raw material, and the craftsmen knew how to exploit all sides of them. Antler and bone were the most used materials, teeth, horn and shells are also attested but numerically not very significant, and are in fact only sporadically selected for the making of ornaments.

Antler was favoured by terramaricole craftspeople: more than 70 % of the exploited raw material stock are antlers. Red deer antler was the first choice with roe-deer contributing only 2 % of the material (fig. 4). Bone is much less used (26 %) and is the result of target oriented selection from butchery refuse. It was exploited in two ways: using the natural shape of the bone or using long splinters. The natural shape of certain bones can often be used with a minimum of transformation, such as for the points made from swine fibula or ulna, where separating the ulna from the radius and sharpening the distal diaphysis is sufficient to complete the tool. The same is the case for metapodial points where after one of the epiphyses is removed, the diaphysis is simply split by fracturing then sharpened afterwards. Most of the time, edges are not even regularised and only the active part is shaped.

In addition, many smaller objects, such as pins, double points, and so on, are made from bone splinters obtained by fracturing. These objects, completely worked, require a more significant investment of time with a much longer chain of operation. In these cases, neither the anatomical origin, nor the animal species are any longer identifiable. At the very most, their general origins can be outlined. They may come from large mammals (horse, cattle, red deer) or small mammals (dog, sheep, pig, roe-deer). The gross anatomical origin can also be deduced by the possibilities offered by certain bones: the long and straight bone pins can be manufactured only from the radius of cattle or horse. For making the finest pins, metapodia of cattle, horse or red deer are needed. These are the only bones which can provide the compact mass and the straightness required for these objects.

Use of teeth is rather rare (1 %) and can only be found amongst the ornamental objects: swine, dog and bear canines underwent very little transformation, with simply a drilled perforation, and a regularisation of the root as far as wild boar tusks are concerned. Towards the end of the terramaricole period, wild boar tusks undergo a more significant transformation with the production of perforated plates or attached beads.

It should also be noted that in the field of the exploitation of hard materials from animals, terramaricole people also worked horn. No horn sheaths have actually been preserved as they are made of a keratinous substance. This activity can be traced through a number of goat, ram and cattle horn cores which have been divided and present marks characteristically resulting from horn sheath removal.

The spectrum of bones used is rather simple. It matches the fauna identified in the culinary waste, without however, reflecting the same proportions (fig. 5). The animal species

used are obviously those found in the faunal assemblage at a given site, but they do not exactly reflect the consumed fauna. Large ruminants (cattle and red deer, and to a lesser extent horse) provide more than half of the bones used, against 35 % of the objects made from the bones of smaller animals (sheep, goat and pig).

On the whole, the exploitation of the skeleton concentrated on certain long bones and ribs (fig. 6-7). The management of the internal skeleton varies according to species: the bovines provide essentially metapodia, ulnae, ribs, and probably radii and tibiae. As far as red deer is concerned, only metapodia could be identified with any certainty although red deer ulna could also have been worked. Horse was scarcely used with only the rudimentary metapodia and the radii manufactured. Of the small mammals, the bones of ovicaprinae are rarely used compared to previous periods; almost all the limb bones were exploited, although tibia and ulna were especially targeted even if only in small quantities. Lastly, exploitation of the pig skeleton is particularly specialised, and directed toward the fibula of young individuals (fig. 6).

If the whole of the osseous material is considered, it can be said that 74% of the terramaricole industry comes from wild animal species and 12 % from domestic animals. The remainder of the industry is drawn from splinters, the anatomical origin of which is no longer identifiable. If deer antler is excluded and only bone material is considered, domestic animal bones provide 39% and wild animals about 10% of the raw material for tools and ornaments.

Amongst the identifiable domestic species, an inversion of the proportions of the animals represented in the faunal assemblage can be noted. In the faunal remains, ovicaprinae are most common followed by swine and then the bovine, based on MNI's (De Grossi Mazzorin & Riedel 1997, Riedel in press). In the osseous industry, cattle, in fact, dominate (ribs and ulna especially). Swine is well represented (fibula in particular) while ovicaprinae bones are seldom selected (approximately 11 % of the domestic species).

Long bone splinters, unidentifiable to species or anatomical part are also important among highly modified objects.

Methods of modification in Terramare artefacts

Approaching the "*schémas opératoires*" in the osseous products implies, from the beginning, good knowledge of the raw materials. Many studies have been carried out on the mechanical properties of osseous materials, primarily on bone (Burr 1980, Parker 1981, Bonnischen 1982, Davis 1985, etc.) and unfortunately fewer on antler (Chapman 1975, Goss 1983, MacGregor & Currey 1983). These properties differ according to various factors: the type of raw material (antler, bone or teeth), the location on the antler or the internal skeleton, the age and the health of the animal and, the state of freshness of the material (green, semi-green, dry), etc.

In all event, the available data generally allow researchers to identify certain technical or functional choices. Studies suggest hard materials from animals did not actually constrain craftspeople, but in fact, offered possibilities that suited their requirements.

Without going into detail, let us briefly recall that the manufacturing process can be divided into three stages: debitage, which aims at production of a support, shaping which incorporates the progressive working of the object, and completion, which is not an essential for the object to be operational and generally results from an aesthetic process.

The various techniques used in manufacturing artefacts from animal hard materials are the same, whatever chronological period is considered. Today, they are relatively well-known thanks to the work of researchers such as M. Newcomer (1974), A. Billamboz (1977), K. Murray (1982), D. V. Campana (1989) as well as all the participants at various conferences on prehistoric osseous products. Nevertheless, because the same terms are not always used to cover the same reality depending on the author, it is wise to define the terminology employed here.

Debitage

These prehistoric techniques were implemented in two principal ways: by breaking or wearing away the raw material. Breaking is implemented by two actions: fracturing and notching.

Fracturing involves violently breaking an element, and can be employed in various manners: using launched percussion, with or without the assistance of a hammer (direct percussion) or by percussion with an intermediate striker (indirect percussion; Provenzano 1997a fig. 5.1-3).

Notching is a form of percussion which cuts the material. It operated in three different ways: in launched percussion, in indirect percussion without a hammer and indirect percussion with a hammer. Wearing away of the material can be achieved employing various techniques (Provenzano 1997a fig. 5.5, 8-9).

Abrasion and *polishing* derive from the same set of technical gestures: the surface is worn by friction using a revolving movement or a to and fro movement. These two concepts are not always clearly defined, and the terms of abrasion and polishing are variously employed, depending on the author, as synonyms or to express different actions. They can be distinguished by the purpose for which they are used, thus pinpointing their place in the operational chain. Abrasion, even if it is fine, is a technique which removes a larger quantity of raw material and which is thus employed either in debitage, or (and especially) in shaping. Polishing is, on the other hand, a technique which removes only a little material (and which functions more to regularise surfaces). Polishing typically takes place during the completion phase, mainly of ornaments or prestige objects.

Scraping, a well-known technological concept in osseous industries, consists of using the edge or cutting edge on an osseous surface with the intention of reducing, regularising or sharpening objects. The tool edge is held perpendicularly to the longitudinal axis of the object to be manufactured and the movement takes place in only one direction along this axis. Lithic and metal instruments can be used for scraping although the marks resulting from their use are very different (Averbouh & Provenzano 1999 fig. 6.b-c).

Grooving consists of cutting a longitudinal furrow in a bone or a deer antler, either with a repeated unidirectional movement or to and fro, using a sharp flint tool or a bronze point. Known and used from the Paleolithic to the Bronze Age, it has often been described, analysed and tested.

Sawing, sometimes compared by mistake to grooving, is an operation which is carried out, in fact, with the back and forth movement of a lithic edge or a metal blade, pushed in a direction perpendicular to the longitudinal axis of the support. The term 'sawing' is thus reserved, in the debitage sequence, for transverse cutting by abrasion, as opposed to grooving which is parallel to the longitudinal axis.

All these techniques may be found at a given time in the realisation of any osseous artefact, whether it dates to the Paleolithic, the Neolithic or the Metal Ages. On the other hand, cultural identity is reflected (in addition to the, more or less, marked predilection for a certain type of raw material) in the methods and processes chosen for the production of the desired objects. In this regard, the personality of the terramaricole craftspeople is particularly marked. The study of the techniques and processes applied in the manufacture of these artefacts was undertaken jointly in very many experimental reconstructions. It became clear that although these craftspeople did not invent new techniques, they employed particular techniques in different frequencies and times throughout the manufacture process. The presence of a very great number of technical pieces (from simple waste products to half-finished or almost completed objects) allowed us to piece together many operational chains, by sometimes supplementing the gaps in the data by the method of refitting by default (see Averbouh in this volume).

Initially, although some rare deer antler fragments with atypical marks give rise to slight doubts, it appears that flint tools are no longer used in the manufacture of osseous artefacts. On the other hand, when identification proved possible, bronze tools are always identified as the source of manufacturing marks, mostly axes, chisels and awls.

The methods of debitage vary little and involve only three techniques: fracturing, notching and sawing. The production of red deer antler always required sliced segments needed to obtain a mass suitable as a core. The cutting of beam and tines took place primarily through launched notching with a bronze axe (fig. 8). Generally, final detachment is insured by simple bending and snapping. The bones, on the other hand, are bro-

ken by fracturing, which is a fast technique but sometimes difficult to control. Thus, red deer and cattle metapodia are chopped longitudinally. The craftspeople inserted a chisel into the centre of the epiphysis and used the natural median furrow of the fused ruminant metapodial bone to guide the line of fracturing, but without any preliminary preparation by slotting as in the Neolithic or early Bronze Age. It is a common technique among terramare craftspeople and one, in fact, which resulted in only a few mistakes. On some specimens the fracturing wave deviated slightly toward the end where the blow was struck. The result was two half metapodials, one of which retained a fragment of the epiphysis and the other, essentially with the rest of the epiphysis. The metapodials were then used just as they were, without any attempt to re-shape the defect.

This method was also employed to split antler beam sections in order to obtain rods. The red deer antler rods and plates are an essential element in the production of small objects (arrowheads, pins, awls, combs etc.).

Towards the end of the period, but at a time still difficult to define with precision, the use of bronze saws is noted. Saws were mostly used in the transverse cutting up of fragments of antler and some bones. It should be noted that, to date, no bronze saw has yet been found in the metal tool assemblages from the terramare. Their presence is thus, indirectly attested by the characteristic marks they left in osseous material. It is possible that broken or worn down metal tools were immediately remelted.

Shaping

The second work phase, shaping, calls for a broader range of techniques: notching, abrasion, slotting, scraping, incision etc. Various processes could be identified in this phase of production, and among these decortication is inevitable. It is found on practically all the objects, from the simple roughing operation to the finest reshaping. Decortication is easily identifiable by the faceted surfaces it leaves. This particular operation comes from notching, implemented in a very specific way. It consists of a series of successive notches which produce joined removals of variable width in the cortical thickness of the material. It employs direct closed percussion or an intermediate tool (chisel or dagger blade). Decortication is often followed at the end of the operation by abrasion, in particular for sharpening arrowheads or bevels, or by polishing to eliminate the last small imperfections and to unify surfaces of very elaborate objects such as pins or combs. The perforations are made two ways: by notching or using a rotary movement which wears away material.

Perforation by notching was carried out with a bronze chisel, and has been noted on large tools with preparation of the surface by coarse decortication over a much wider surface than the perforation itself. This makes it possible to regularise the surface and to decrease the thickness to be perforated (fig. 10). The rotary movement perforation is intended for smaller,

more fragile objects. It is in particular the case for all needles where the eye is perforated using this technique or for perforated teeth. This type of perforation was also employed in openwork, one of the characteristic elements of these terramare industries. To create openings in certain objects like lyre peg heads, combs with handles or wheel-shaped pin-heads with rays, work first begins by making a small circular perforation which will be enlarged either by notching (on the pins) or followed by several other small adjoining perforations. These perforations will ultimately make possible the elimination of the central plate, for example, in the semicircular handles of the combs or the rays of the wheel-shaped pin-heads (fig. 11).

Finally, one other characteristic of the terramaricole osseous product is the concept of the composite tool, where various elements (made from the same or different materials) are put together with pegs to create a complete tool. This is probably the case for the large perforated artefacts which, it seems, must have been combined with other elements to produce an object, where the final morphology is still unknown. This method of using pegs to combine various elements into a single unit is attested in many other objects such as some osseous perforated plates which are, in fact, dagger handle covers (Provenzano 1997c fig. 298.17). Another such combined object is the small artefact from the Redù terramare made from a antler tine cylinder in which an osseous plate with several perforations is fixed by a red deer antler peg: this unit must have been associated with other elements to constitute a complete object of unknown function. Another small similar object comes from the terramare of Montale, where a small cylinder made from a terminal tine was found. This cylinder still retained a small red deer antler tenon (Provenzano 1997c fig 295.20). A similar small wooden peg, which crosses through a quadrangular perforation of a bridle cheekpiece from the Parma terramare is of note (Provenzano 1997c, fig. 298).

Pegs (*tenon*) are also used (this time without any concept of assembly) to consolidate chisel handles made from antler beam or large tines. During the part of the manufacturing involving tool percussion, the bronze chisel is likely to sink into the spongy central zone of the antler, which is too fragile. This risk is avoided by the inserting a small transversal peg of compact red deer antler against which the bronze chisel hits before the end of the stroke.

Removal of the first tine by notching and regularization by decortication is shown in fig.9/a while perforation of the burr by notching may be seen in fig. 9/b-c.

The production of a bevelled end and preparation of the perforation by decortication as well as the beginning of a perforation using a bronze chisel can all be seen in this half-finished antler axe from the terramare of Montal (fig.10).

Osseous terramaricole products: Choices and an established “*savoir faire*”

Hard materials from animals played an important role in the terramare economy. They are present in various technical systems and, as finished products, seem to have been used most in domestic, agricultural and handicraft activities. As half-finished goods they were probably important in trade, implying that certain craftspeople were semi-specialised. The abundant series represents a corpus, from the simplest to the most complex of objects comprised of identifying elements allowing us to understand the technical systems and the role of osseous materials in the Italian middle and late Bronze Age economies.

The acquisition of raw materials shows reasoned and planned strategies of provisioning. Paradoxically, with the reduction of the forest caused by the extension of open spaces (and thus the distance to the red deer habitat) caused by human activity, the use of deer antler notably increased. The low importance of hunting is indicated by the rarity of antlers with pedicles and the small quantity of deer bone found in kitchen refuse. This implies the organised collection of shed red deer antlers at the end of the winter, as well as their storage and protection from bad weather and scavenging animals. Only very rare traces of gnawing on red deer antler were observed, whereas it is extremely frequent in the faunal material (Riedel, in press). The collection of roe-deer antlers seems, on the other hand, related to an opportunist behavior linked to chance discoveries during autumn, even if their bones and antlers with pedicle attached are present in small quantities at the sites. Wild boar and bears were valued by the people of the terramare for their canines. Only very rarely have bear bones been found in the bone assemblages, and as the habitat for this animal lies beyond the terramaricole area, the presence of its canines is certainly the result of barter with other alpine or Appennine communities.

The meat contributed by hunting (especially red deer, rarely roe-deer and wild boar) was limited. It was the domestic livestock which contributed the essential part of the meat from the usual cattle-pig-ovicaprinae triangle. It should be noted that the importance of pastoral activities increased during the terramaricole period. It is mainly from this stock, composed of domestic animals, that craftspeople drew, although this was not a necessity. Red deer metapodia have always been systematically required for the production of the stereotypic long points based on split metapodia. This demonstrates a really strong selection since if only metapodials were used in manufacturing, the entire red deer carcass must still have been dragged back from the kill site. In addition, although the ovicaprinae bones are numerically more significant (around 50 %), they were partly ignored as a raw material in favour of the less abundant bovine bones (around 15 %; De Grossi Mazzorin 1996).

Nevertheless, these results must be moderated by the fact that most of the objects have been so heavily modified that it is no

longer possible to identify the body part, supports were drawn from. In fact, craftspeople preferred to base their work on bone splinters rather than preserving the natural form around the active part of the tool. Ovicaprinae tibiae and metapodia must certainly have been used more than it appears here. In the Neolithic and early Bronze Ages they were often preserved intact with one end simply bevelled or sharpened. In the tool series from the terramaricole sites, only one point from a complete sheep metapodial was collected while the central diaphysis of tibiae were used in the manufacture of small tubes.

This attitude exemplifies general workmanship tendencies among terramaricole craftspeople. With the exception of large red deer antler tools and of some large bone points (primarily from ulna) which are barely modified, the remaining utensils are based on raw material fragments, in the form of splinters, rods and preformed plates.

If the technical pieces made from deer antler are numerous, those from bone are, in contrast, not very common: if some objects derive from a particular stage in the manufacturing process, there are only a few bone objects from cutting waste. We first thought that this was due to the mode of debitage by fracturing long bones, which did not allow them to be differentiated from refuse bones. We thought for a long time that the craftspeople chose their bones from kitchen refuse, the bones or splinters fit for the desired object. However, if the types and frequency of fractures observed by archeozoologists in faunal remains are analysed, it can be noted that the majority of the bones are broken in mid-diaphysis, probably in order to extract the marrow (Riedel in press). The principal goal of the craftsperson on the other hand, was to maintain the integrity of the diaphysis. They must have sorted and put the desired bones aside, making this selection before culinary activities (and not at the end of the consumption chain). This assertion does not contradict the fact that there was selection of splinters from the household refuse, which obviously existed, but only tends to minimise its importance.

That the manufacture of hard animal materials was *in situ* is attested by the great number of technical pieces present on these sites. If some of these utensils certainly come from private domestic production, an important part probably belongs to a semi-specialised product. Unfortunately no such “workshop” or specialised activity area has ever been identified, even in correctly and recently excavated sites such as the terramare of Santa Rosa. The stratigraphy observed in terramare sites is always extremely complex since these settlements were occupied without interruption over 200 to 300 years and the environs of the site must have been continuously cleaned and restructured so that only a few levels remain undisturbed. It is a problem frequently encountered on sites with long settlement histories, where it is often difficult to associate an object with an event or a type of event, a difficulty increasing with stratigraphic complexity (Choyke 1983).

As has been previously noted (Choyke 1987), we must abandon the common idea that the coming of metal caused other raw materials to be abandoned (flint, bone, deer antler). This partiality for osseous materials (and especially for deer antler) is not restricted to terramare: it can be observed, for example, at sites from the same period on the Great Hungarian Plain (Choyke 1987). In northern Italy, inter-site and inter-region variations can be observed in the stock of raw material (depending on proximity to deer habitats, the increasing importance of cattle or pig etc.). However, a constant preference for deer and then for cattle osseous products (even if they are still being studied right now) seems to be characteristic. Cultural variations appear more discretely as far as the types of objects are concerned. In terramare, a genuine typological outburst can be noted in comparison to the early Bronze Age, with special reference to arrowheads and ornamental elements. We found in plenty, the three main types of artefacts: technical parts, tools and weapons, and ornamental elements. A certain diversity is found among tool types at different terramare which can partly be explained by the environment they were located in. For example, large deer antler tools employed in agriculture and forestry (such as axes and hoes) are numerous in the piedmont areas of Modena province, while they are scarcely found in the low Po Plain. Other objects, such as combs or pins, are much more numerous in the central area (Parma/Reggio-Emilia). It is possible that there was specialised production in this area, perhaps with an eye to bartering. But whether a semi-specialised craftsmanship existed or not is still hard to say. Even when the good preservation phenomena – of particular importance in the Terramare and Alpine Lakes area – are discounted, the beginning of the middle Bronze Age, seems to mark an important technical change. Great attention was paid to hard materials from animals as expressed in the “*savoir-faire*” shown in the making of almost all objects, the great diversity of bone artefact types and the appearance of new types, such as wheel-shaped pin-heads, handles with individualised heads, and bridle cheek piece bits. The great *koinè* of the Bronze Age is often mentioned. Unfortunately, synthetic studies are still too scarce to enable us to make large scale comparisons, or to detect the common or different lifeways of these cultures.

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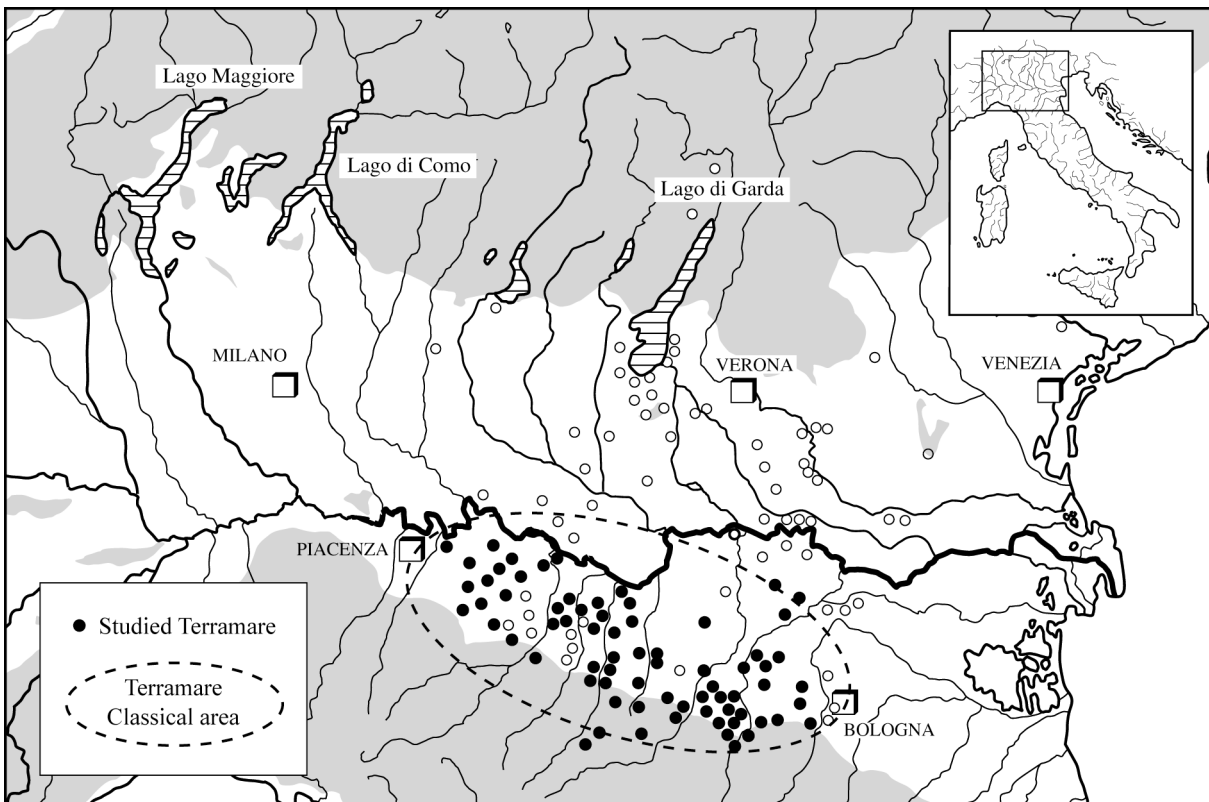


Fig. 1 Principal settlements of Bronze Age in septentrional Italy. The terramaricole culture extends into three distinct ecosystems: primarily the base plain, the Appennin piedmont area and to a lesser extent the mountain area.

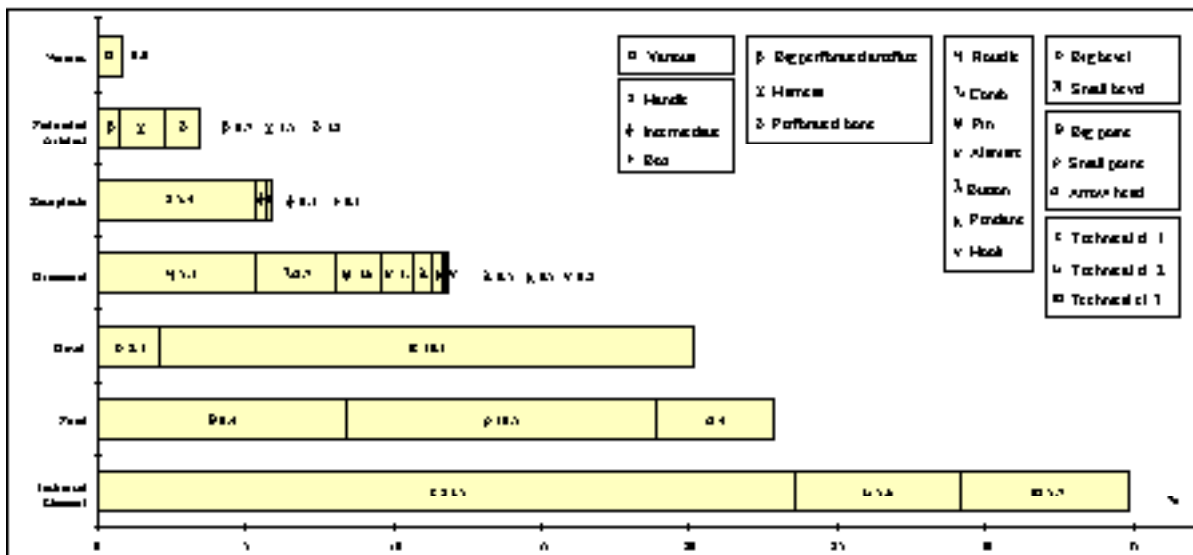


Fig. 2 Distribution of the objects by typological groups

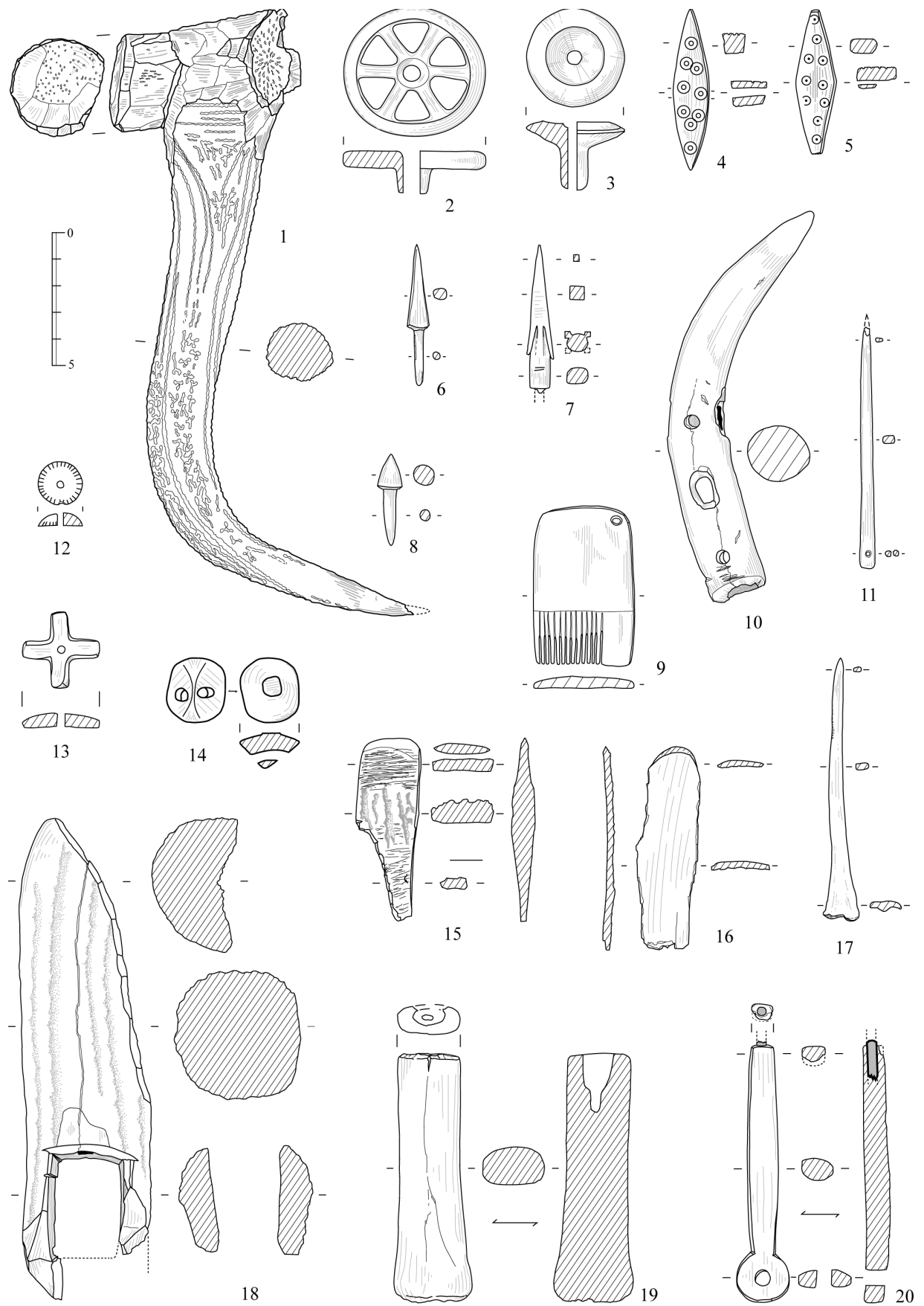
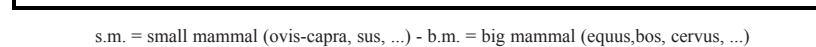


Fig. 3 Principles of Terramaricole bone production: Antler: 1-10, 12, 15, 18-20, Bone: 11, 16-17, Wild boar tusk: 13-14
Montale: 1, 4-6, 18, Redù: 2, 20, Castione: 3, 9-10, Gorzano: 7, 13-17, 19, S. Rosa: 8, 11, Casinalbo-Necropoli: 12



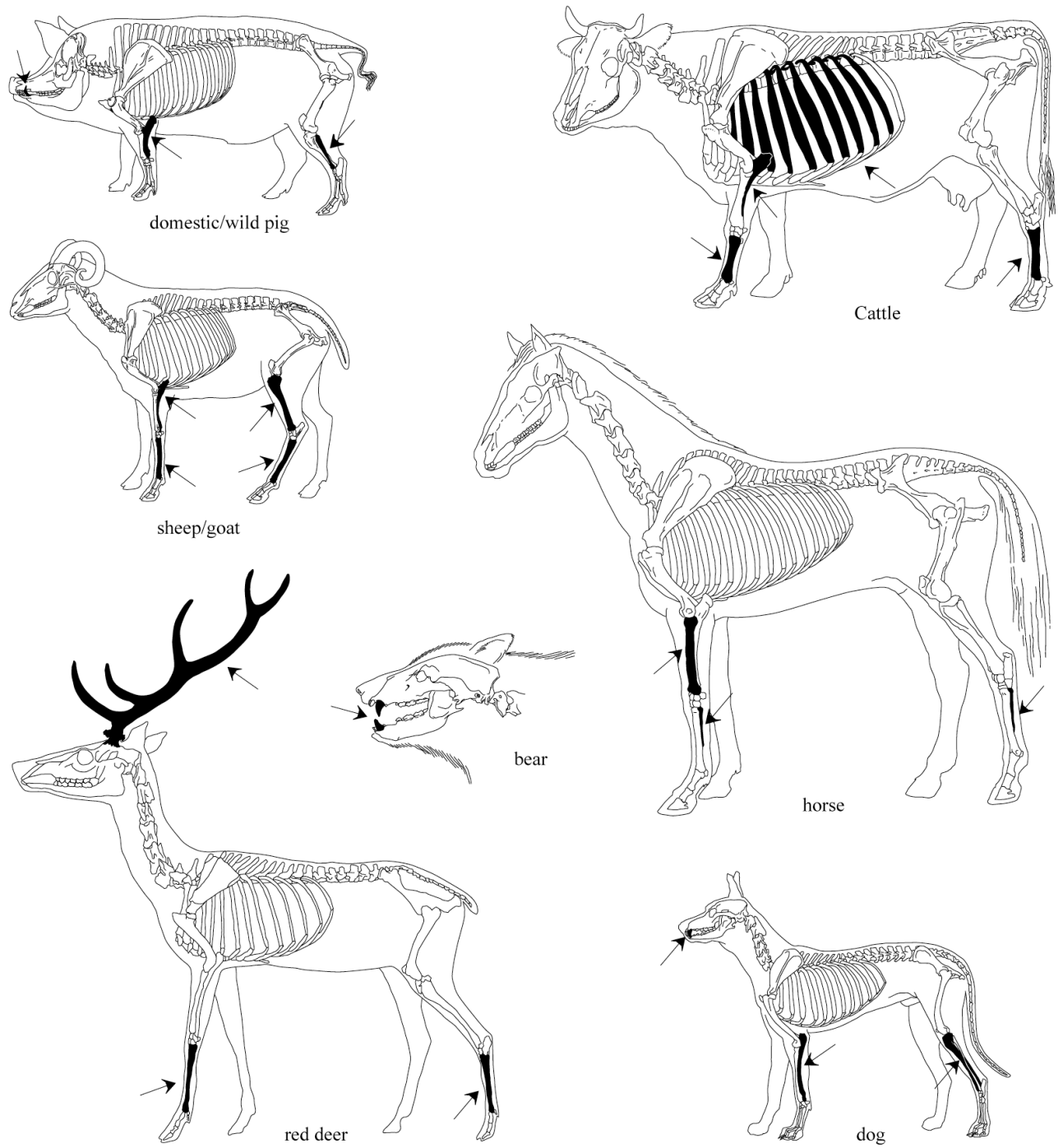


Fig. 6 Origins of the identified raw materials

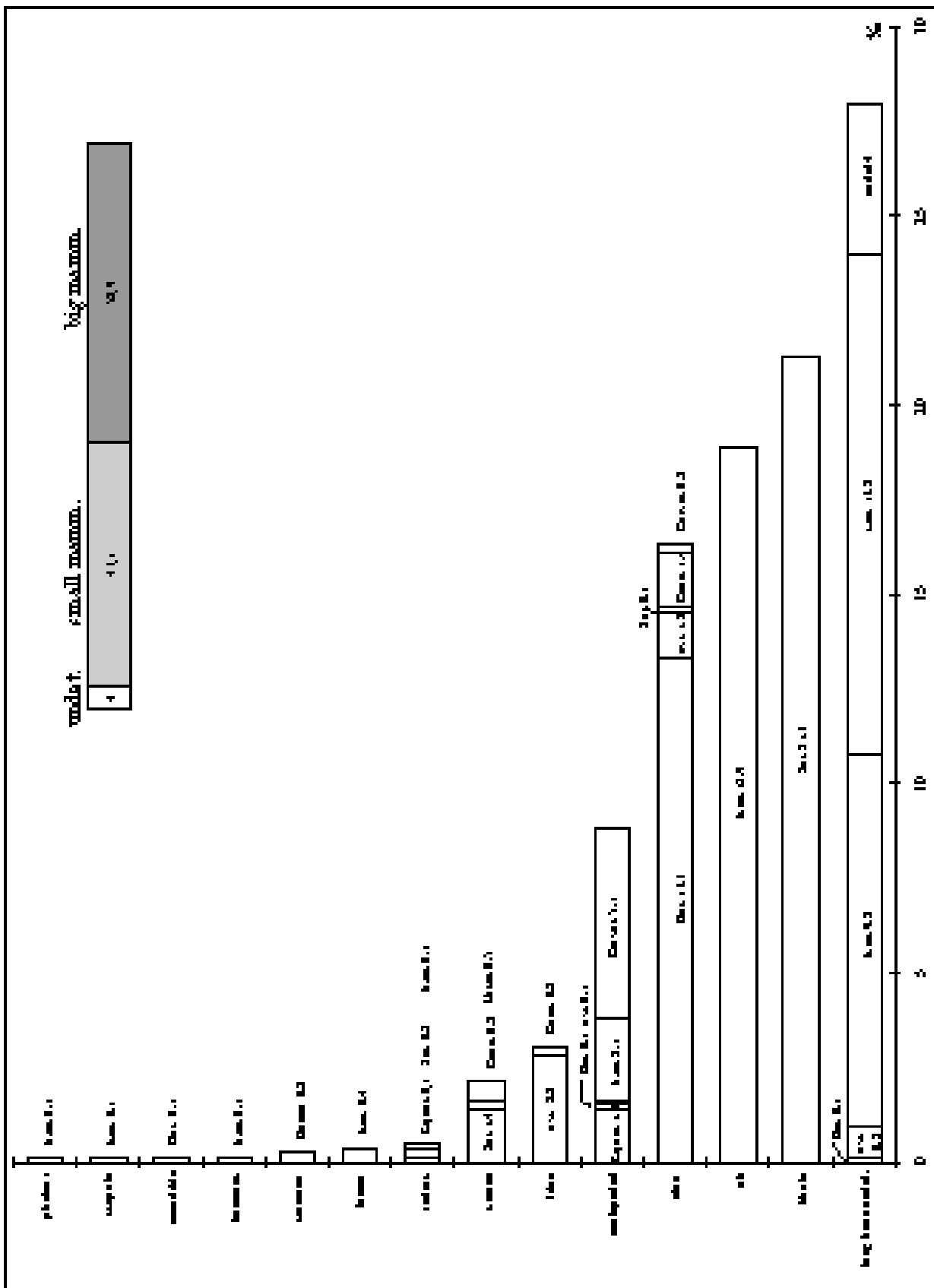


Fig. 7 Exploitation of the elements of the internal skeleton

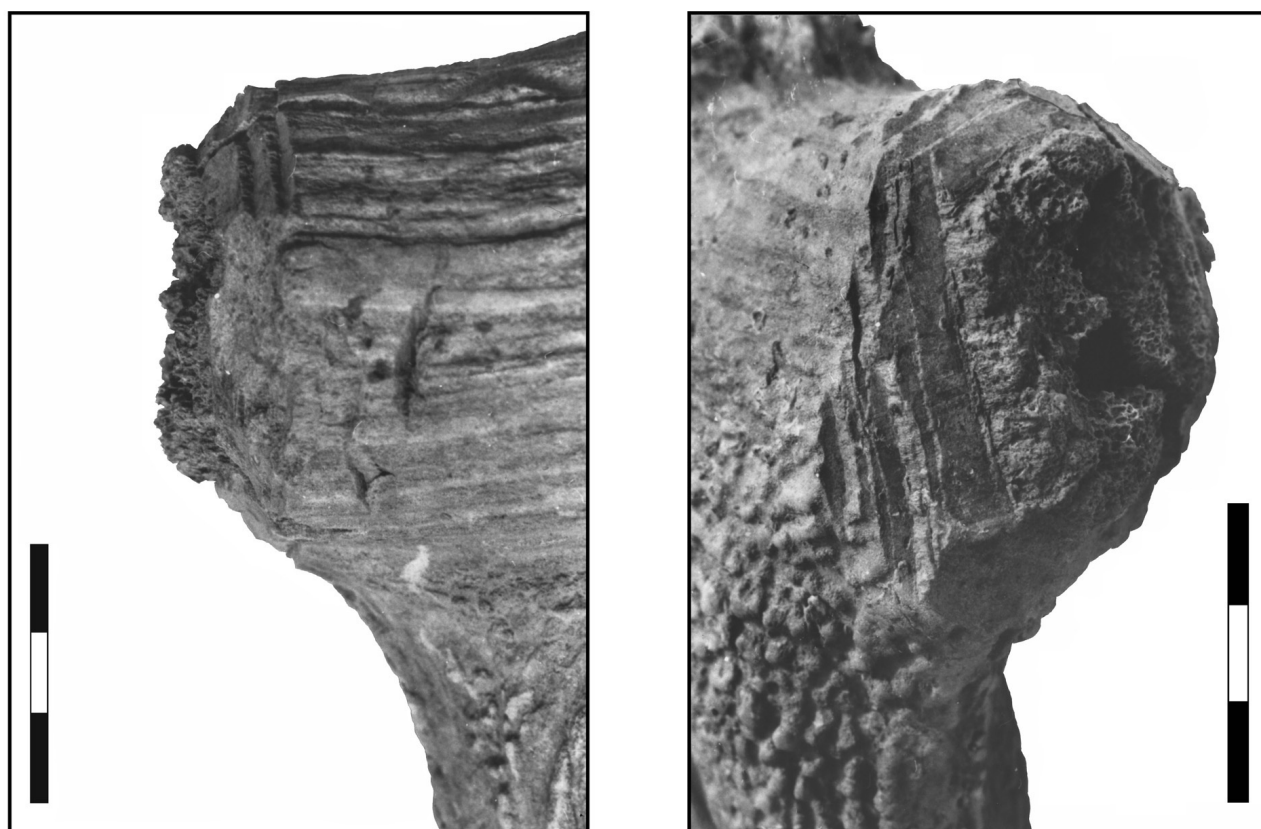


Fig. 8 Cutting of an antler beam by launched notching using a bronze axe



Fig. 9 Large perforated artefact from the Terramare of Montale

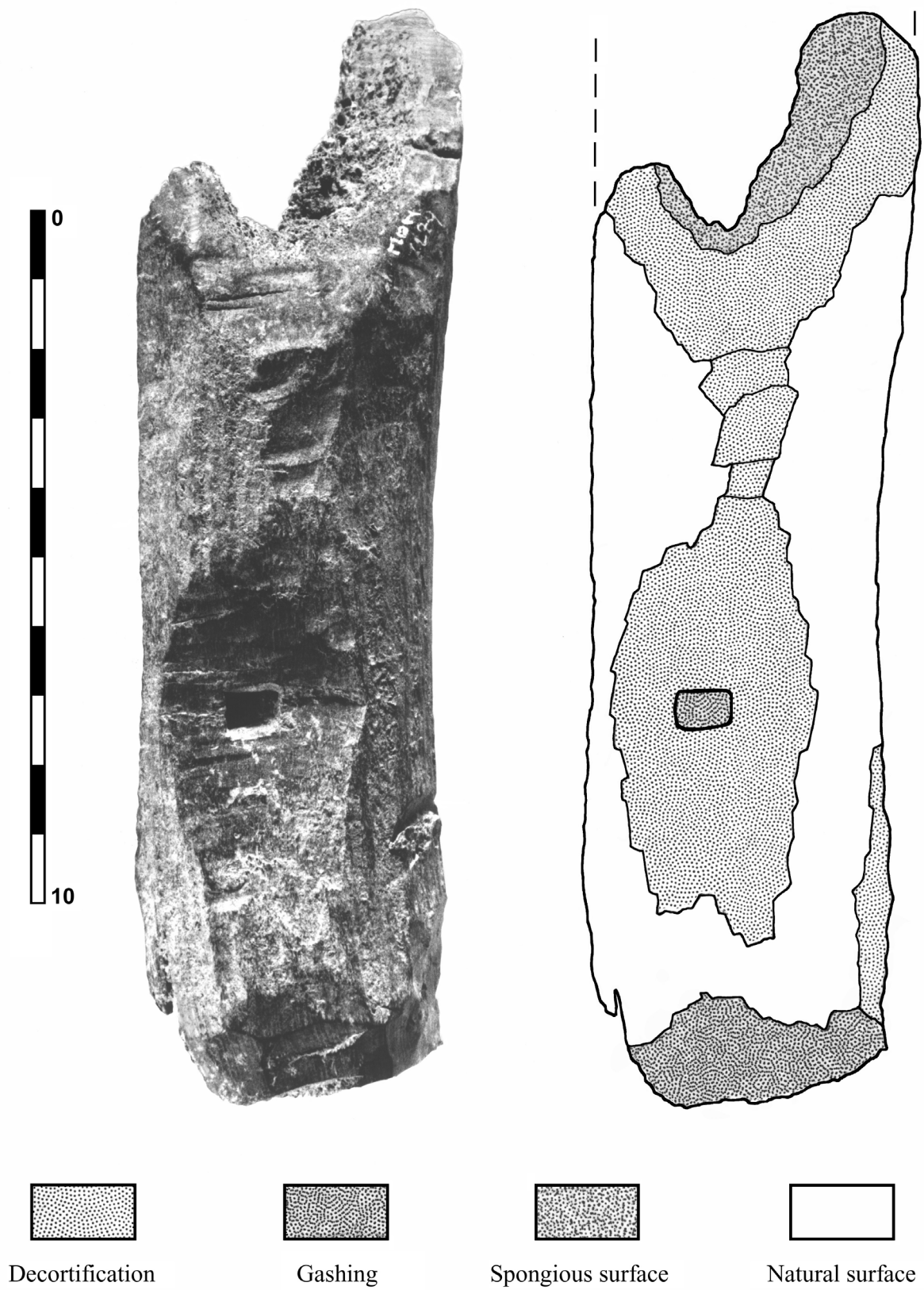


Fig. 10 Antler axe discarded in the stage of manufacturing (Terramare of Montale, Modena)

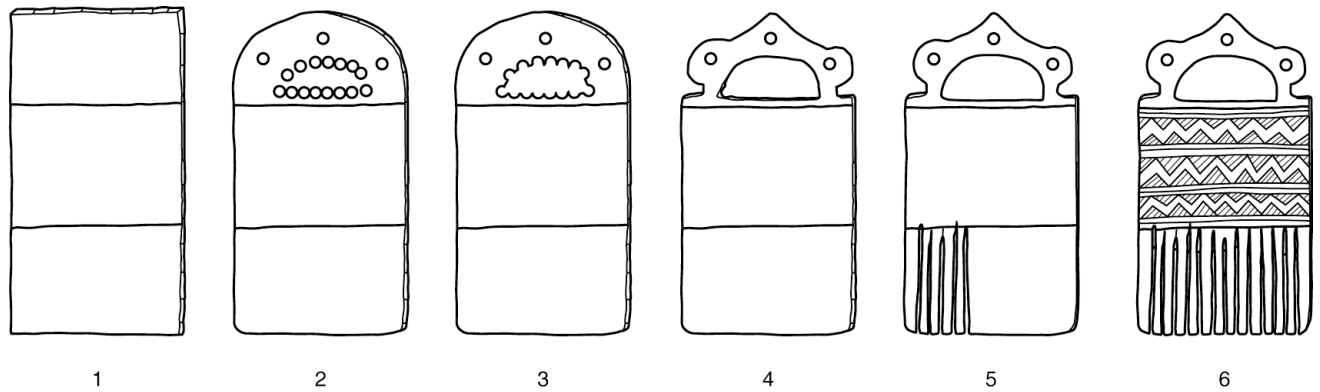


Fig. 11 Stages of manufacture of a deer antler comb from the Middle Bronze 2

- 1 - Plate on beam carefully decorticated on both faces with almost a total removal of the spongiosa,
 - fine abrasion of the whole
 - demarcation of registers by 2 transversal incisions: handle zone, comb corps, teeth zone
- 2 - roughing out/trimming of the general shape by decortication
 - successive perforations for the handle openwork (perforations can be very close)
 - setting of the 3 ornamental perforations of the handle
- 3 removal of the central plate in order to create the handle
- 4 Shaping of the handle around the 3 perforations
- 5 Elaboration of teeth by bifacial grooving
- 6 - Abrasion of the proximal part in order to regularize teeth front
 - Fine polishing of the whole comb
 - Incision of the design integrating the two original transversal incisions to the pattern