CRAFTING BONE – SKELETAL TECHNOLOGIES THROUGH TIME AND SPACE

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

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Special Assemblages

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

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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.

THE ANTLER, BONE AND TOOTH TOOLS OF SWIFTERBANT, THE NETHERLANDS

(c. 5500 – 4000 cal. BC) compared with those from other Neolithic sites in the Netherlands

E.E. Bulten and Anneke Clason

Abstract: These antler, bone and tooth tools were first studied, described and drawn by the first author in the eighties as part of a student doctoral thesis. Last year, Raemakers (1999) described in his thesis the Swifterbant culture and the Neolithic sites he considered to belong to this culture, in addition to the Swifterbant site. He based the allotment of these sites to the Swifterbant culture on a study of these sites, subsistence, stone tools and pottery, but left the antler, bone and tooth tools out of his considerations. We will compare the tools from Swifterbant with those and other Neolithic sites in the Netherlands.

Keywords: The Netherlands, Neolithic, antler, bone and tooth tools

Résumé: Ces outils aménagés sur os, bois de cervidé et dents ont d'abord été étudiés, décrits et dessinés dans les années 1980 par le premier auteur à l'occasion de sa thèse de doctorat. L'année dernière, Raemakers (1999) a décrit dans sa thèse la culture de Swifterbant ainsi que les sites qu'il considère s'y rapporter, en plus du site éponyme. Il a fondé l'attribution de ces sites à cette culture sur leur étude du point de vue de l'économie de subsistance, de l'industrie lithique et de la céramique, mais n'a pas pris en considération les outils en os, bois de cervidé et dents. Nous comparerons les outils de Swifterbant avec ceux des autres sites de cette culture ainsi qu'avec ceux d'autres sites néolithiques des Pays-Bas.

Mots-clés: Pays-Bas, Néolithique, outils en os, bois de cervidé et dents

Zusammenfassung: Die vorliegenden Geweih-, Knochen- und Zahngeräte wurden von E. Bulten bereits in den 80iger Jahren im Rahmen einer studentischen Abschlußarbeit untersucht, beschrieben und gezeichnet. Im vergangenen Jahr hat Raemakers (1999) eine Dissertation über die Swifterbant-Kultur mit dem Fundplatz Swifterbant selbst und dazugehörigen neolithischen Fundplätzen vorgelegt. Er stützt die Zuweisung dieser Plätze zur Swifterbant-Kultur auf Studien zur lokalen Subsistenzwirtschaft, zu Steingeräten und Keramik, läßt aber die Geweih-, Knochen- und Zahngeräte außer Acht. Wir hingegen wollen diese Artefakte aus Swifterbant mit denen anderer neolithischer Lokalitäten aus den Niederlanden vergleichen.

Schlüsselworte: Niederlande, Neolithikum, Geweih-, Knochen- und Zahnartefakte

Introduction

The antler, bone and tooth tools were first studied, described and drawn by the first author in the eighties as part of a student doctoral thesis (Bulten 1988). Last year, Raemakers (1999) described in his thesis the Swifterbant culture and the Neolithic sites he considered to belong to this culture, in addition to the Swifterbant site. He based the allocation of these sites to the Swifterbant culture on the study of these sites, subsistence, stone tools and pottery, but left the antler, bone and tooth tools out of his considerations. We will compare the tools from Swifterbant with those sites and other Neolithic sites in the Netherlands (fig. 1).

Swifterbant

The tools of Swifterbant were collected during excavation at sites S3 and S5 (fig. 2) over a period from 1972-1977 by the former Biological-Archaeological Institute in Groningen under the direction of J.D. van der Waals, then Professor at Groningen.

The tools from Swifterbant were found among numerous animal bones at site S3, which was situated on a low levee alongside a creek. A large single unit was excavated, representing more than half of the actual settlement (Van der Waals 1977, cited by J.T. Zeiler 1997). Only a small section (S5) of the creek bank was excavated. The largest part of the tools came from S3, and only a small number derived from S5 (13 of 174) (fig. 3).

In fig. 3 an overview is given of the excavation trenches and the years in which they were excavated. During the excavation, every find of 1 cm and larger was three-dimensionally registered and separately numbered. The surface plan of the earth was collected by square meters in layers of 10 cm and thereafter water-sieved.

The numbers with five ciphers indicate tools from levee S3. The numbers with six ciphers beginning with 9 denote finds from the creek bank S5, with a total 13 specimens.

A scheme of the parts of the antler rack used in producing the antler tools is shown in fig. 4.

The tools

The preservation of the tools is reasonably good, but in many cases their outer surface is corroded and in those cases it is not possible to see the ways in which the objects were fabricated and used. A number of the tools show traces of burning.

Three categories of preservation could be distinguished:
- good: the surface is smooth, fabrication traces are visible;
- moderate: the surface is not smooth, fabrication traces are difficult to see;
- bad: fabrication traces are invisible.

Traces of working and traces of use. Carving was, if not otherwise indicated, always carried out from the outside towards the bone marrow cavity to produce two or more strips of bone, especially from metapodials. Polishing results in smoothness. The same effect, however, is produced by handling the artifact and by the use of the working end on soft materials (Van den Broeke 1983).

Measurements are given in mm. If the measurement is given in brackets it indicates that the object must have been larger. The weights are given in grams. The individual tools listed in the Appendix have been described with regard to:

a. find number
b. preservation
c. contact with fire
d. measurements (l=length, b=breadth, d=depth)
e. weight
f. description
g. fabrication traces and traces of use

The find number of all the tools and waste pieces presented here are listed in the Appendix. The most spectacular tools from every category have been described in a tabulated form and depicted.

The choice of raw material

The inhabitants of Swifterbant kept domestic cattle, sheep/goat, domestic pig and dog. They hunted a variety of large and small mammals, such as wild pig, aurochs and red deer and birds (Zeiler 1997) while they fished catfish among others (Brinkhuizen 1976).

Tab. 1 shows that percentages of domestic mammals, wild mammals, birds and fishes in the bone count are more or less equal to those represented by the tool and waste group. Red deer artifacts and waste pieces were relatively numerous (tab. 2). A few long bones of aurochs were used for the production of socketed axes and the mandibular canine of a wild boar and the fibulae of the same species were used to produce knives, gouges and awls. Sixty-nine pieces could not be identified as to species.

The fabrication

Antler tools

Most of the tools made from red deer antler were carved out of the antler with a sharp and/or pointed flint tool. The scratches of the flints on the cortex are still clearly visible. The spongiosa was broken across after carving the cortex. Another way to sever parts of the antler was to chop or chip the cortex away and then again break the spongiosa. The oblique working parts of the axes were obtained by carving the cortex and spongiosa half way through and then breaking the beam in such a way that an oblique plane remained on both parts of the broken beam. This is best illustrated by the T-axe and waste from T-axe fabrication. For the manufacture of the base-axe, the brow and base tines were cut or chopped off and the spongiosa broken. The shaft hole was constructed between the brow and bez tines. The shaft hole was carved or chopped out of the cortex. The working edge was constructed more or less parallel to the shaft hole. There are two types of base axes, one with the shaft hole running anterior/posterior (I) and a second type with the shaft hole running lateral/medial (II). These are not only morphologically different tools but also functionally different. The strength of the standard measure of elasticity and the working force necessary to break the antler are greater along the length of the antler than in the transverse direction. The shaft hole that conforms to this structure is less likely to spoil it than one which does not. Because the shaft hole of base-axe II conforms to the structure, these base-axes must be stronger than base-axe I where the shaft hole is transverse to the structure of the antler. In Spoolde, of the c. 47 type I base-axes were found, mostly damaged and with only four undamaged. Of the four base-axe II's from that site, two were undamaged and two slightly damaged. Also, the place and the direction of the shaft hole relative to the working edge and the length and weight of the tool would have decided the usefulness of the tool.

One tool was made from an unshed antler, and two were shed antlers. Of all the other antler tools and waste fragments, it could not be established whether they were from hunted deer or naturally shed. It was also impossible to say whether they were used directly after shedding and collecting or hunting, or whether they were hoarded after collecting to be used later.

Bone tools

Especially on those tools made from the metapodia of red deer and/or cattle, carving traces from the flint tools used in their manufacture are often visible lengthwise as the bone was carved and broken. The working traces are often visible. Working smoothed out the grinding traces. After that, the working end, either a point or a gouge edge, was polished. Pointed bones were also used as awls, although they were not prepared for this purpose but were just lying around and handy. The polished point shows that the bone was used. The fibulae of the wild boar may belong to this category.

	Bones		Tools and waste	
	N	%	N	%
Domestic mammals	423	3,5	7	5,5
Wild domestic mammals	1375	11,42	21	16,66
Unidentified mammals	2252	18,71	27	21,42
Bird	7524	62,52	69	54,76
Fish	459	3,8	1	0,79
	-	-	1	0,79
Sum	12033		126	
Red deer antlers			48	
Sum			174	

Tab. 1 The percentages of the bones of different animal groups compared with those of the same groups found in the tools and waste of Swifterbant

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Elk antler																				
Chisel	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-
Adze	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
Shafted axe	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
Base axe	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Red deer antler																				
T-axe	+	+	-	5	-	-	-	-	-	2	1	3	13	-	-	-	-	-	-	-
Waste T-axe/hammer	+	+	-	4	-	-	-	4	-	-	-	-	17	-	-	-	-	-	2	1
Shafted axe	-	-	-	8	-	-	-	1	-	3	-	-	8	-	-	-	3	-	-	-
Tapering beam axe	-	+	-	-	1?	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-
Base axe I	-	-	-	-	-	-	-	-	-	2	-	1	53	-	-	-	-	-	-	-
Base axe II	-	-	1	-	1?	-	-	-	-	-	-	1	4	-	-	-	-	-	-	-
Shafted beam axe holder	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pick	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Bone																				
Socketed bone axe	-	+	-	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Two-pronged object	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Metapodium gouge	-	-	-	1	-	2(1)	-	-	4	-	-	-	-	-	-	3	-	1	1	1
Long bone gouge	-	-	1	3	-	-	-	5	-	-	-	-	-	1	-	3	7	-	2	-
Radius gouge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Arrow point?	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-
Awl	+	-	1	68	1	1	-	24	9	-	-	-	1	2	-	20	11	-	71	7
Fibula &c. awl	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Gorge	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	1	-	-	6	-
Fish hook	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Rib spatula	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	1	-	2	-
Bone disc	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bead	-	-	-	-	-	-	-	2	-	-	-	-	-	1	-	2	1	2	-	1
Wild boar mandibular canine																				
Gouge	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Knife	-	-	-	3	-	-	-	2	-	-	-	-	-	-	-	8	-	-	-	-

Tab. 2 The antler, bone and tooth tools from Neolithic sites in the Netherlands. ENA/B: 1. Hoge Vaart, 2. Hardinxveld-Giesendam; ENB/MNA: 3. P14; MNA: 4. Swifterbant, 5. Emmeloord, 6. Hazendonk 2, 7. Rijckholt-St. Geertruid, 8. Vlaardingen, 9. Hazendonk 3; ENA-?: 10. Deventer, 11. Hardenberg, 12. De Gaste, 13. Spoolde; MNB: 14. Hazendonk Vl-1b, 15. Zandwerven, 16. Hekelingen III; LNA: 17. Hazendonk Vl-2b, 18. Zeewijk, 19. Kolhorn; LNA/B: 20. P14.

EBA	2000-1300 BC
LNB	2450-2000 BC
LNA	2900-2450 BC
MNB	3400-2900 BC
MNA	4100-3400 BC
ENB	4900-4100 BC
ENA	5300-4900 BC

Tab. 3 The periods used in tab. 2 or the text

Tooth tools

The gouges and knives made out of the lammellae of the lower mandibular Canine of a male wild boar were carved with flint knives. In the case of the gouges the working edge was fashioned in the same manner as the bone gouges.

The function of the tools

It is difficult to say much about the function of these tools. That the Swifterbant tools were used intensively is clear by the state they are found in. Most are damaged and broken, and some have been in contact with fire. Much experimental work still has to be done on the production and use of antler, bone and tooth tools (ie. Schibler, this volume).

Comparisons with other Dutch Neolithic sites of the same, older or younger periods

These sites include:

The ENA/B sites of Hooge Vaart (Hogestijn & Peeters 1996; Laarman 1996) and Hardinxveld/Giesendam (Polderweg and De Bruin [Louwe Kooijmans 1998]); the ENB/MNA site of P14 (Gehasse 1995); the MNA site of Emmeloord (ADE nd); Hazendonk 2 (Van den Broeke 1983) and Rijckholt-St. Geertruid (Clason 1998); the ENA/? sites of Deventer (Verlinde 1982) Hardenberg and De Gaste and Spoolde (Clason [1983] 1986); the MNA sites of Vlaardingen (Clason n.d.); and Hazendonk 3 (Van den Broeke 1983) and Hazendonk 3; the MNB sites of Hazendonk VI-1b (Van den Broeke 19..), Zandwerven (Clason 1962), Hekelingen III (Maarleveld 1985); the LNA sites of Hazendonk V-26 (Van den Broeke 1983) , Zeewijk (Gerrets et al. 1988) and Kolhorn (Hokse 1989/1990) and as last the LNA/Br site of P14 (Gehasse 1995).

Of these sites, shown in fig. 1, the tools of Spoolde, P14, Hazendonk, Rijckholt-St Geertruid, Deventer and Zandwerven were published. There are no finished or preliminary publications on the material from the other sites.

If we look at tab. 2, we see that tools from elk antler were only found at Spoolde. The use of red deer antler is more common on the Early and Middle Neolithic sites. It has to be kept in mind that the finds from both Deventer and Spoolde were found during dredging in the foreshore of the river IIjssel (Clason [1983] 1986; Verlinde 1982) and it is not certain that the objects belong together. From Deventer there are actually two different ^{14}C-dates from wooden shafts GrN-10460 c. 2820±70 BP and GrN-10459 3050±80 BP. That little or no antler is found in Zeewijk, Zandwerven and Kolhorn is not surprising as they are situated in an open landscape near the sea in the north of the province of North Holland. Antlers are also scarce in the layers of the Hazendonk. This may be because the tools were only found in discarded material on the flanks of the sanddune (*donk*) on which the settlement was situated. However, at Swifterbant, 13 tools were found in the creek beside the settlement.

T-axes were found in the older settlements and in those with a mixture of older and younger stone tools and pottery (Clason 1986; Raemakers 1999). Waste from T-axe fabrication was found at Hardinxveld/Giesendam and at Spoolde. The waste pieces could be used both as axes or hammers with the brow tines used as handles. The remains of eight shafted axes were collected in Swifterbant. Similar tools are also known from Deventer, Spoolde, Vlaardingen and Hazendonk Vl 2-6.

If we look at the bone tools, we see that three socketed axes were found at Swifterbant (fig. 13), at least one in Hardinxveld/Giesendam and one in Spoolde. The two-pronged object from Swifterbant was also found in Deventer. Gouges and awls are known from most sites.

Typical of Swifterbant were 10 awls made from the fibulae of wild boar. Only one other such tool is known from Kolhorn. Not found in Swifterbant but in Zandwerven is a gouge made of cattle radius. Similar gouges are more common in Central Europe (Clason 1985; 1991a) and the west of Asian Turkey (Clason 1991b).

Other tools that are typical of Swifterbant are the gouges and knives made from the mandibular canine of wild boar. Similar knives were also found in Vlaardingen and Hekelingen III. They are more common in Central Europe. In general, it can be said that the Neolithic inhabitants of the Netherlands manufactured 28 types of antler, bone, and tooth tools. The most usual were antler axes and bone awls.

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Appendix

1 Antler
1.1 Red deer (*Cervus elaphus* L.)
1.1.1 T-axes: 910194; 7411; 57445; 45159; 31025
1.1.2 Waste from T-axe manufacturing: 910215; 910116 (A); 910144; 910116 (B)
1.1.3 Shafted axes: 53821; 54297; 53029; 2264; 910498; 52681; 910049; 1090
1.1.4 Waste: 55838; 53521 + 53520; 28724; 55306; 54730; 54584; 54130; 47009; 23086; 22227; 1926
1.1.5 Beam fragments: 910091; 910243; 54846; 54712; 54116; 45158; 54927; 42726; 910741; 56096
1.1.6 Tines: 910505; 2840; 17402; IX.15i; 1175; 35947; 42900; 15972
1.1.7 Crown: 52473A; 52473B

1.2 Elk (*Alces alces* L.)
1.2.1 Tine, not worked: 52609

Antler tools – detailed description of characteristic specimens

Find No.	Preservation	Fire	Dimensions	Weight	Description	Traces of fabrication and use
1.1.1 T-axes						
7411	moderate	none	l=151.1 b= 56.8 d= 41.8	189 g	Fragment of a T-axe made from a red deer antler. The cortex of one side is worn off. The axe is broken through the shaft hole. The working edge is missing. The shaft hole is located at the trez tine	The surface is corroded, which makes the observation of traces difficult, the preserved part may have been used as a hammer, the shaft hole displays traces of gnawing but also of drilling (fig. 5)
57445	good	none	l=(108.7) b=55.0 d=34.6 f=145	145 g	The axe is broken along the shaft hole at the place of the trez tine and a second has been drilled	The surface is polished, the working edge is heavily damaged, but just visible (fig. 6)
910194	moderate	none	l=(134.7) b=48.2 d=30.2	114 g	The T-axe is broken along the shaft-hole at the position of the trez tine. The cutting edge is missing, the other end is rather rough	Much of the surface is polished (fig. 7)
1.1.2 Waste from T-axe manufacturing						
910215	good	none	l=169.7 b=85.0 d=35.9	252 g	Not naturally shed	The beam was carved and then broken off. Part of the pedicle could have been used as a hammer. The point of the brow tine is broken off. There is an unfinished shaft hole in the brow tine. It is not clear whether this was bored or cut (fig. 8)
910116	good	none	l=160.7 b=88.7 d=40	214 g	The base and brow tine of a shed red deer antler. The tip of the brow tine is missing. Part of the burr is missing (not visible in the figure, the base was grawed and untidily broken off	There is no indication that it was used (fig. 9)
1.1.3 Shafted axes						
53029	bad	none	l=165.0 b=45.2 d=40.2	144 g	Part of the beam of a red deer antler	Broken off at the shaft hole, the shaft hole was probably drilled and is polished, the end was straight, the working edge was curved (fig. 10)

2. Bone
2.1 Bone axes
2.1.1 Socketed bone axes: 8088A; 8088B; 52575
2.2 Two-pronged object
2.2.1 Unsocketed axe: 55007

Bone axes – detailed description of characteristic specimens

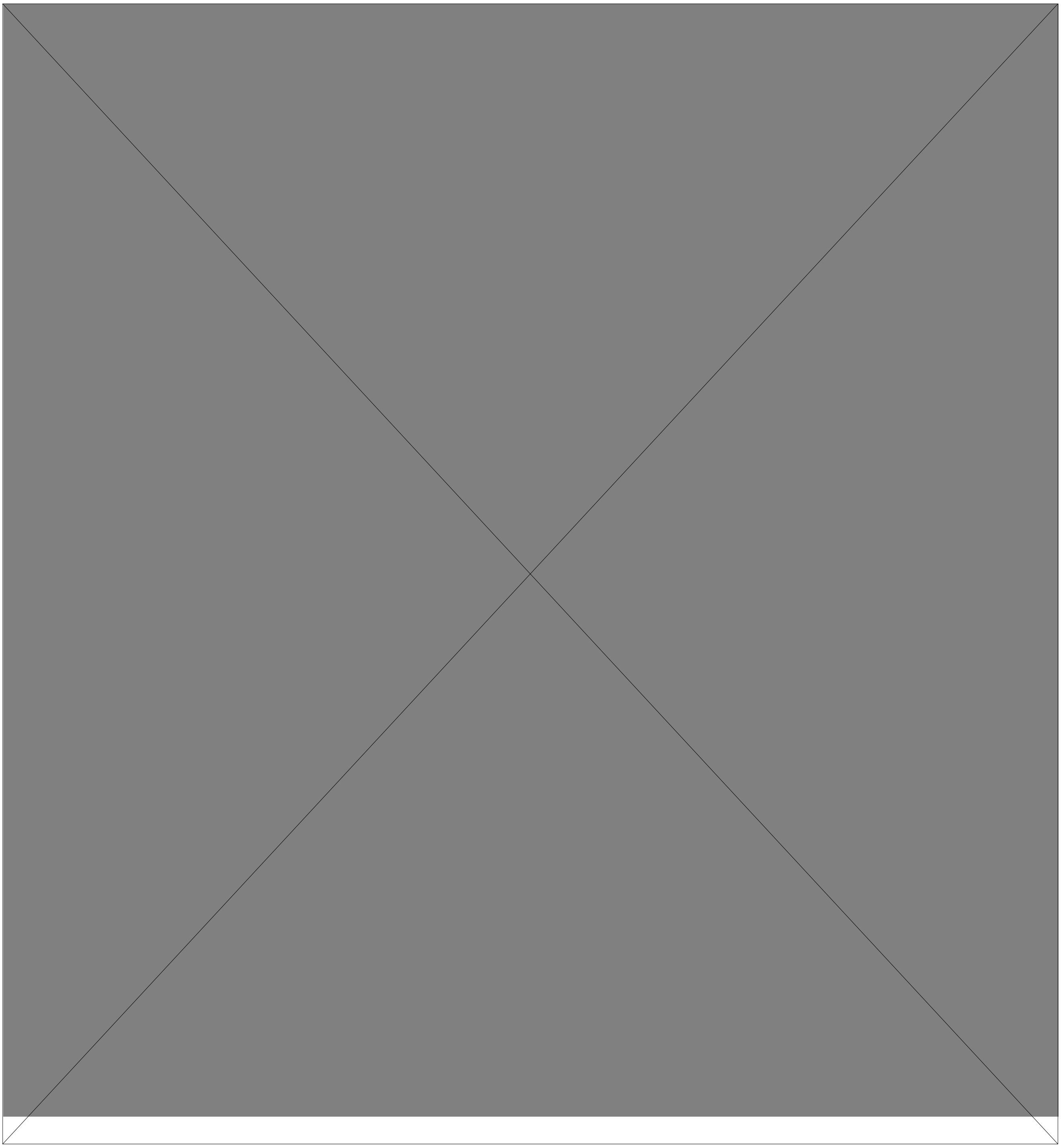
Find No.	Preservation	Fire	Dimensions	Weight	Description	Traces of fabrication and use
2.1.1 Socketed axes						
8088	moderate	none	l=170.5 b=106.0 c=50.4	264.7 g	Axe made from the proximal part of an aurochs (*Bos primigenius* Boj.) left radius	The working end was cut from the dorsal part of the bone. A hole has been made in the proximal articular face of the bone. The shaft hole has a circumference of c. 20.0 mm across. The working edge is partly broken off. The remaining part was used as a gouge (fig. 11)
52575	good	none	l=77.7 b=60.1 d=36.2	46 g	Socketed axe made from the proximal end of the left radius of domestic cattle (*Bos taurus* L.)	A shaft hole was made in the proximal articular face of the bone. The hole is smooth and broken probably because the shaft put too much pressure on the gouge. The working edge is 38.2 mm across (fig. 12)
2.2 Two-pronged object						
55007	good	possible	l= 85.2 b=42 d=43.9	57 g	Left metatarsus from domestic cattle (*Bos taurus* L.)	The use of this object is unclear (fig.13)

2.3 Bone gouges
2.3.1 Metapodium gouge: 31843
2.3.2 Metapodium waste: 910221; 32458
2.3.3 Gouge, long bone diaphysis: 23040; 53285; 52952

Gouges – detailed description of characteristic specimens

Find No.	Preservation	Fire	Dimensions	Weight	Description	Traces of fabrication and use
2.3.1	*Metapodium gouge*					
31843	good	none	l=158.3	389 g	A gouge made of the proximal end and diaphysis of a metatarsus of domestic cattle (*Bos taurus* L.)	The object is smooth and the working end undamaged. Probably the object was used to work soft material, possibly hides. A function as dagger is also possibility. Cuts and scratches are still visible on both long sides. The working edge is fashioned both from the outside and inside. The inside of the 'gouge' is smooth. One of the best items in the collection (fig. 14)
2.3.2	*Metapodium waste*					
910221	good	none	l=73.83 b=24.1 d=20.7	17 g	Fragment of a metatarsus of a red deer (*Cervus elaphus* L.)	Traces of carving originating from a flint tool (fig. 15)
32458	good/ moderate	none	l=101.3 b=28.3 d=13.5	29 g	Fragment of a metatarsus of a red deer (*Cervus elaphus* L.) or domestic cattle (*Bos taurus* L.)	The bone is split lengthwise, with carving scratches visible on one side (fig. 16)
2.3.3	*Long bone gouge*					
23040	good	none	l=(67.9) b=46.8 d=24.4	26 g	Gouge made from a long bone of a large ruminant	The straight edge is ground on both sides. The other end is broken. On the working side there parallel scratches are visible, which may be possible grinding scratches, although it can be that they were produced as the gouge was used (fig. 17)
53285	good	none	l=(82.0) b=24.8 c=8.2	9 g	Gouge made from the long bone of swine or small ruminant. The open epiphysis is still visible on the proximal end	The artefact is damaged. The surface is smooth and shows polish scratches. Fabrication marks are gone (fig. 18)
52952	moderate	none	l=(53.1) b=21.5 d=6	6 g	Fragment of long bone of an animal of the size of a large ruminant or wild boar (*Sus scrofa* L.)	The artefact is flattened, the working edge is sharp (fig. 19)

2.4 Bone awls
2.4.1 Catfish (*Silurus glanis* L.) pectoral fin ray: 45949
2.4.2 Horse (*Equus caballus* L.) II/IV metatarsus: 53887
2.4.3 Domestic or wild pig (*Sus scrofa* L./*Sus domesticus* Erxl.) fibula: 57324; 52750; 45201; 910502; 36357; 36949; 19208; 46385; 31533; IX/21H
2.4.4 Gorge. Double-pointed bone rod: 35969; 903412; 42888; 56210
2.4.5 Awl made from red deer (*Cervus elaphus* L.) scapula: 28600
2.4.6 Awl made from a long bone: 26402; 17109; 15148; 404304; 51520; 51540; 52102; 46602; 1888; 38839; 39341; 33449; 34105; 16948; 26060; 47416; 49774
2.4.7 Awl made from a metapodium: 28260; 57715; 30704; ? A + B; 41483; XX206; 54147; 54447; 51438; 46061 + 46062; 42960; 34179; 35831; 36467; 36794; 19284; 17540; 2071
2.4.8 Damaged awl without point made from a long bone: 32885; 41187; 56746; 51561; 1345; 13179; 29; 34444; 40060; 41184; 35416; 18985
2.4.9 Awl tips: 83859; XXV176; XVII19H; X/29F; X2071; IX/24F; IX/16F; 49720; 53305; 903406
2.4.10 Crane (*Grus grus*) right radius awl: 30490



2.5 Worked bone of unknown function: VI/24b/; 27526; V/26F; V/186; VIII234; XV.19F; 30245; X/22H; 50554; 52311; 53286; 55110H(770); XX.20H; XIV.24H; XIV.21F; X/141; X/14ia; VII-22G; 36559; 49624; 31466; 17085.

3 Lamella of a wild boar (*Sus scrofa* L.) tusk
3.1 Gouges: 33156; 22303; 22226; 40374; 42984; 54956; 55880
3.2 Knives: 16440; 39090; 42522
3.3 Waste: 39046; 38774; 38338; 43935; 45249; 31782; 4203; 22205; 55286

Lamella from the mandibular tusk of wild boar (*Sus scrofa* L.) – detailed description of characteristic specimens

Find No.	Preservation	Fire	Dimensions	Weight	Description	Traces of fabrication and use
3.1	*Gouges*					
33156	good	none	l=45.2 b=23.0 d=15.8	10 g	Double gouge made from the lamella of the mandibular canine of a wild boar (*Sus scrofa* L.)	Both ends are sharpened. There are no other traces of fabrication or use (fig. 30)
3.2	*Knives*					
16940	good	none	l=(61.2) b=21.7 d=2.9	4 g	Lamella from the mandibular canine of a wild boar (*Sus scrofa* L.)	The inner side has been polished smooth. Scratches are visible at the end parallel. The enamel also shows polishing scratches. The broken off point may have functioned as an awl, but more likely the object was used as a kind of knife (fig. 31)
39090	good	none	l=87.7 b=25.6 d=6.4	8g	Lamella from the right canine teeth from a wild boar (*Sus scrofa* L.)	The inside is smoothed. Polishing scratches are visible at the distal r. side. The proximal end was ground into a cutting edge. It was possibly used as a knife (fig. 32)
3.3	*Waste*					
39046	good	none	l=63.0 b=22.3 d=11.6	14 g	A lamella from the right mandibular canine from a wild boar (*Sus scrofa* L.)	The distal end is broken off. The proximal side is sharpened. Parallel scratches at right angles to the length are visible. The outside has no work traces (fig. 33)
4203	good	none	l=132.6 b=16.9 d=14.3	N.A.	Complete right mandibular canine from wild boar (*Sus scrofa* L.)	The object is split lengthwise. Deep carving traces can be observed along the edges. The enamel at the outside shows no wear traces. Possibly the object was used as a knife after the lammellae were removed to make other objects, in that case it is waste (fig. 34)

References

Archeologisch Diensten Centrum, n. d. Pamphlet.

Brinkhuizen, D. C. 1976. De visresten van Swifterbant. *Westerheem* 25, pp. 246-252.

Broeke, P. W. van den 1983. *Neolithic bone and antler objects from the Hazendonk near Molenaarsgraaf (prov. South Holland)*. Hazendonk Paper 2, Hazendonk.

Bulten, E. E. B. 1988. *De beenindustrie van Swifterbant. Een onderzoek naar het bewerkte skeletmateriaal van de vindplaatsen S3 en S5*. Student doctoral thesis. University of Groningen.

Clason, A. T. 1962. Nieuwe opgravingen van de neolithische nederzetting te Zandwerven, gem. Opmeer, III (New excavations at the neolithic settlement of Zandwerven, Opmeer district). *West-Frieslands Oud en Nieuw* 29, pp. 210-219.

Clason, A. T. 1985. B. Animal bones and implements. In *Makotøasy: a TRB site in Bohemia*, ed. E. Pleslová-Stiková. Fontes Arch. Pragensis 17, Prague, pp. 137-162, 280.

Clason, A. T. (1983) 1986. Spoolde, Worked and unworked antlers and bone tools from Spoolde, De Gaste, the IJsselmeerpolders and adjacent areas. *Palaeohistoria* 25, pp. 77-130.

Clason, A. T. 1986. Het voorkomen van het wilde paard *Equus ferus* Boddaert, 1785 in Nederland vanaf het laat-glaciaal (A Late Glacial occurrence of wild horse *Equus ferus* Boddaert, 1785 in the Netherlands). *Lutra* 29, pp. 303-306.

Clason, A. T. 1991a. Viehzucht, Jagd und Knochenindustrie der Pfyner Kultur. In *Niederwil, eine Siedlung der Pfyner Kultur. Band III: Naturwissenschaftliche Untersuchungen*, ed. H. T. Waterbolk. Paul Haupt Bern/Stuttgart, pp. 115-217.

Clason, A. T. 1991b. De radius-beitels van Ilippinar, Turkije (The radius chisels from Ilippinar, Turkey). *Paleo-Aktueel* 2, pp. 40-41.

Clason, A.T. 1998. De vuursteenmijnwerker als boer, jager en geweiverzamelaar (the flint miner as farmer, hunter and antler gatherer), in: ed. P.C.M. Rademakers, *De prehistorische vuursteenmijnen van Rijkholt-St. Geertruid* (The flint mines at Rijckholt-St. Geertruid). Nederlandse Geologische Vereniging, afd. Limburg, p. 219-229.

Gehasse, E. F. 1995. *Ecologisch-archeologisch onderzoek van het Neolithicum en de vroege bronstijd in de Noordoostpolder met de nadruk op vindplaats P14* (Environmental archaeological research in the Neolithic and the question of Bronze Age in Noordoostpolder with an emphasis on Site P14). Thesis, University of Amsterdam.

Gerrets, D. A. *et al.* 1988. *De laat-neolithische nederzetting Zeewijk* (The late neolithic settlement of Zeewijk). Riksuniversiteit Groningen, Groningen.

Hokse, A. 1989/1990. *Werktuigen van been en hertshoorn* (Tools made from bone and antler). Manuscript.

Hoogestijn, J. W. H. & H. Peeters 1996. Opgravingen van de mesolithische en vroegneolithische bewoningsresten van de vindplaats Hooge Vaart' bij Almere, Flevoland province: Een blik op een duistere periode van de Nederlandse prehistorie (Excavations at the mesolithic and early neolithic settlement remains at the site of Hooge Vaart' bij Almere, prov. Fl.: A look at an obscure period of prehistory in the Netherlands). *Archeologie* 7, pp. 80-113.

Laarman, F. 1996. Archeozoölogie (Archaeozoology). In *Opgravingen van de mesolithische en vroeg-neolithische vindplaats Hoge Vaart A27 in de tracé van de A27 (gem. Almere, prov. Flevoland)*, eds. J. W. H. Hoogestijn & J. H. P. Peeters, Rapportage Archeologische Monumentenzorg. Rijksdienst voor het Outheidkundig Bodemonderzoek, Amersfoort, manuscript.

Louwe Kooijmans, L. P. 1998. Jachtkampen uit de steentijd te Hardinxveld-Giessendam (Stone Age hunting camp at Hardinxveld-Giessendam). *Spiegel Historiael* 10, p. 33.

Maarleveld, Th. J. 1985. *Been en tand als grondstof in de Vlaardingen-cultuur* (Bone and tooth as raw materials in the Vlaardingen culture). Student doctoral thesis, University of Leiden.

Raemaekers, D. C. M. 1999. *The articulation of a 'New Neolithic'*. Thesis, Archaeological Studies Leiden University 3, Leiden.

Verlinde, A. 1982. Deponierte landwirdschaftliche Geräte aus Hirschgeweih in der IJssel bij Deventer. *Berichten, Rijksdienst voor het Outheidkundig Bodemonderzoek* 32, pp. 209-218.

Zeiler, J. T. 1997. *Hunting, fowling and stock-breeding at Neolithic sites in the western and Central Netherlands*. Thesis, Archaeo-Bone, Rijksuniversiteit Groningen.

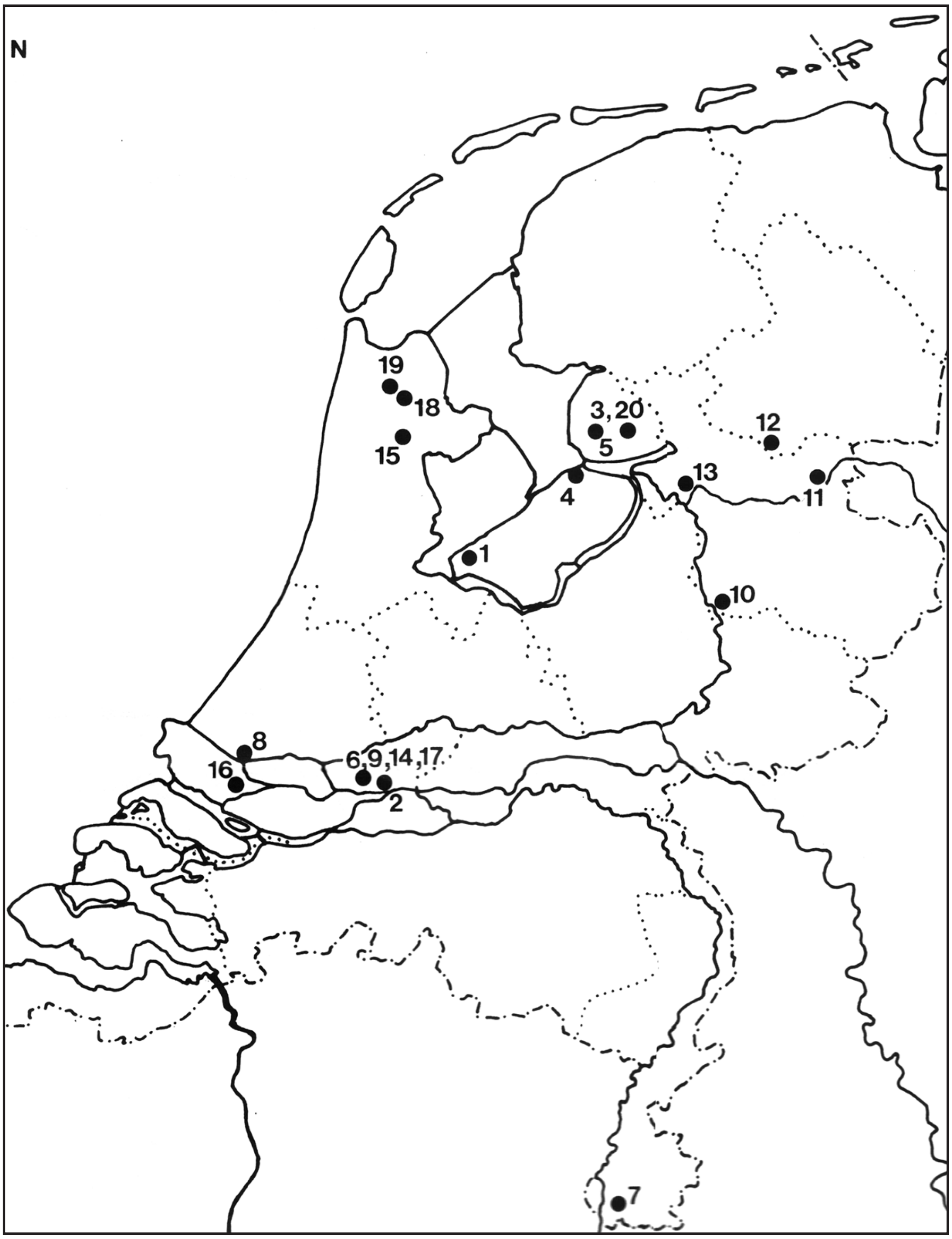


Fig. 1 Swifterbant and other Neolithic sites in the Netherlands. For the names of the sites see tab. 2

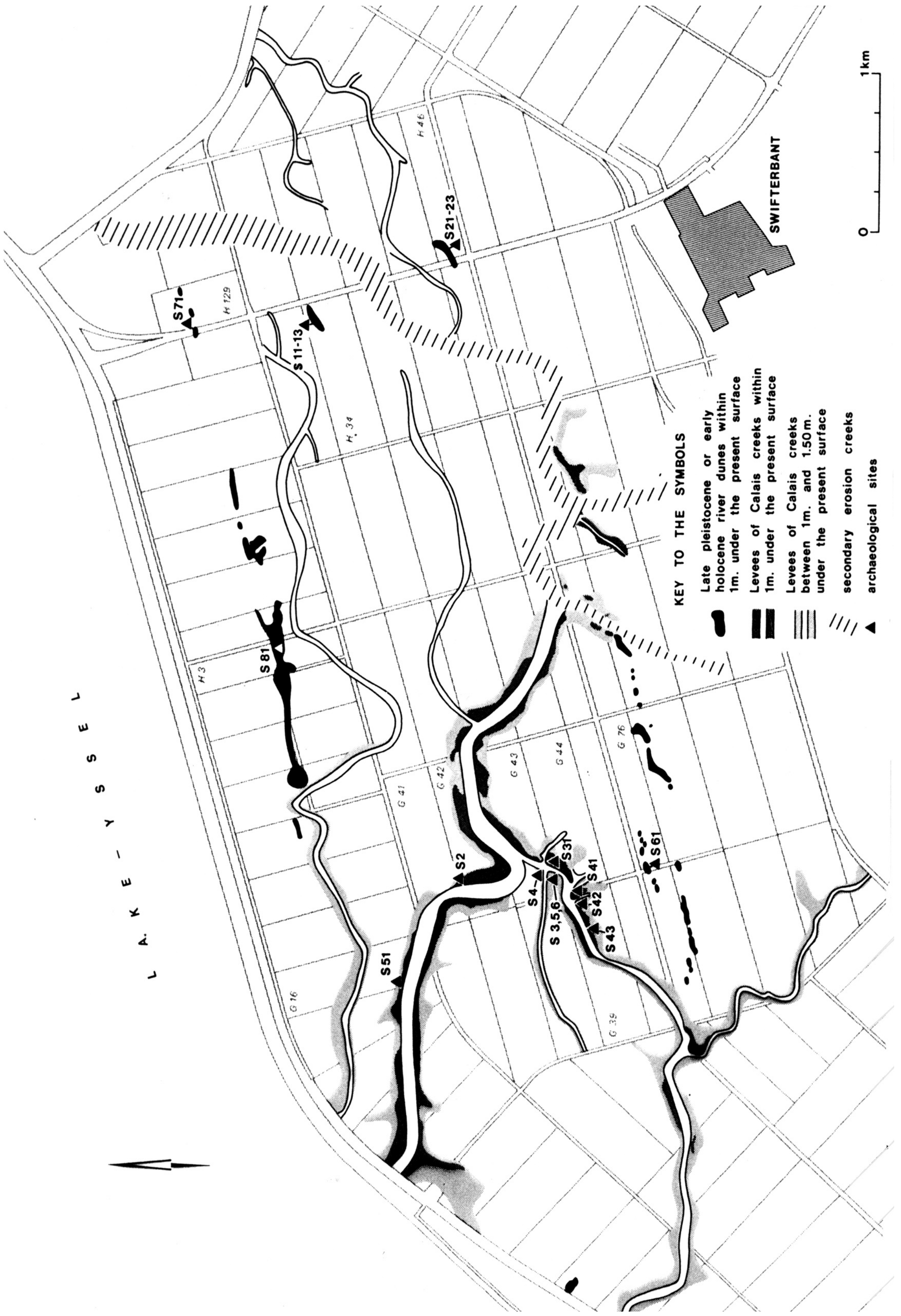


Fig. 2 The location of Mesolithic sites on river dunes and Neolithic sites on levees in the area NW of Swifterbant (from Zeiler 1997). Drawing by G. Delger/J. Klein

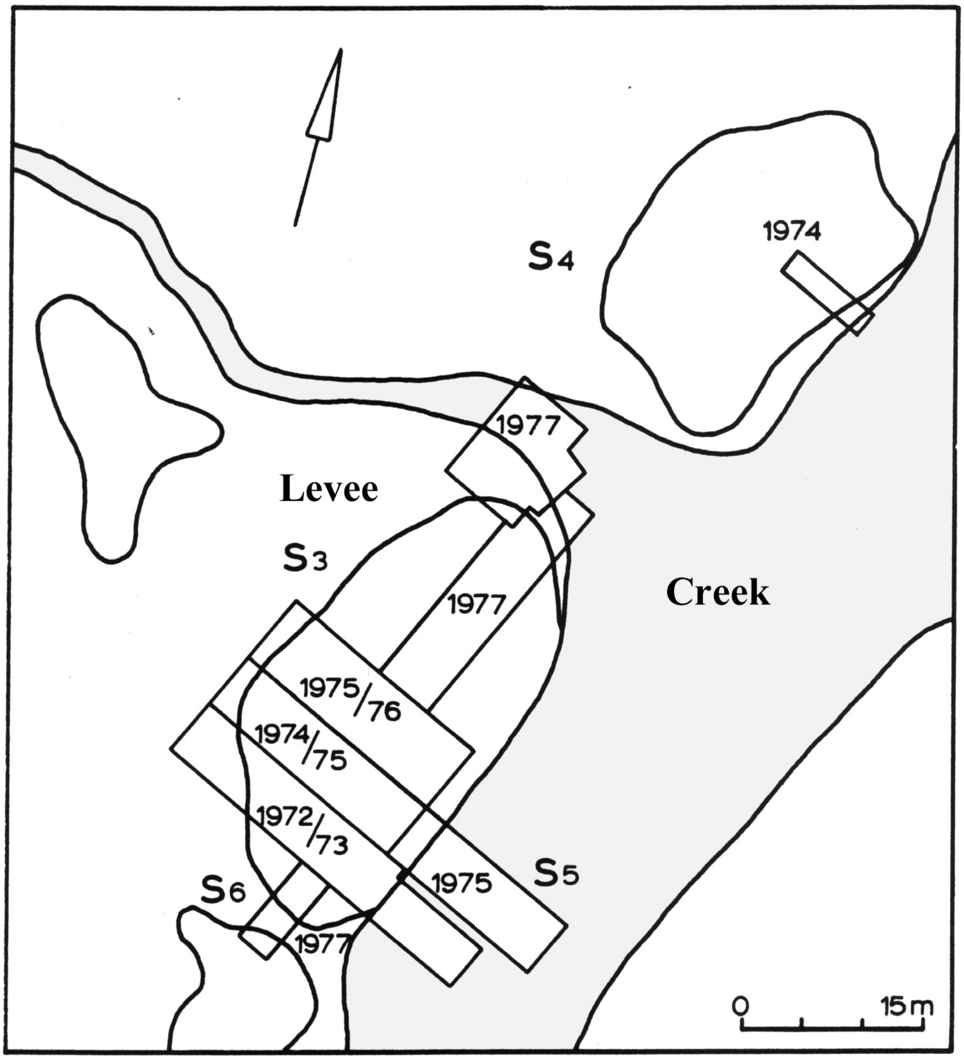


Fig. 3 Swifterbant. The sites S3, S4, S5 and S6 with the excavation trenches (1972-1977). Drawing J.H. Zwier

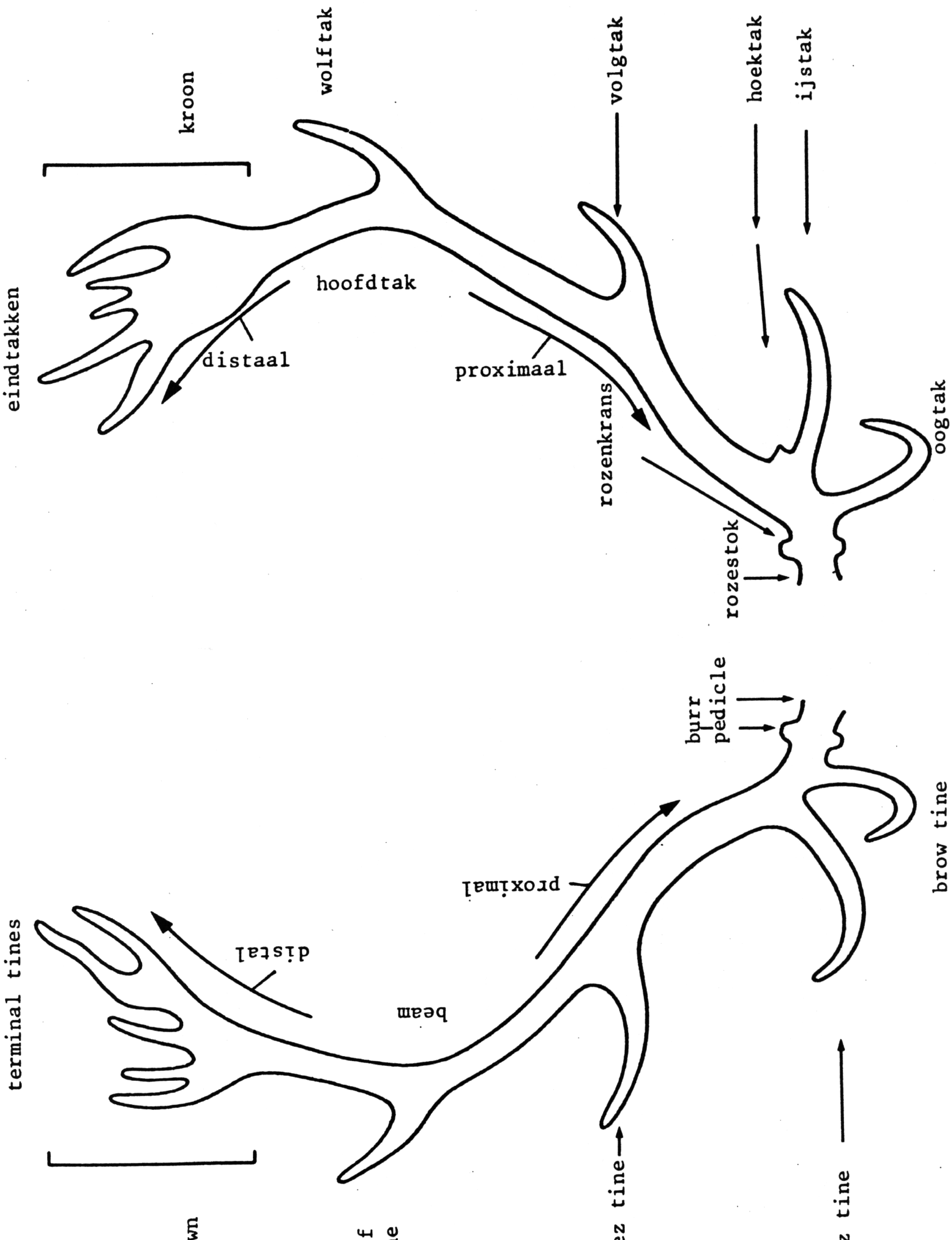


Fig. 4 Explanation of the names used for describing red deer antler tools. Drawing J.M. Smit

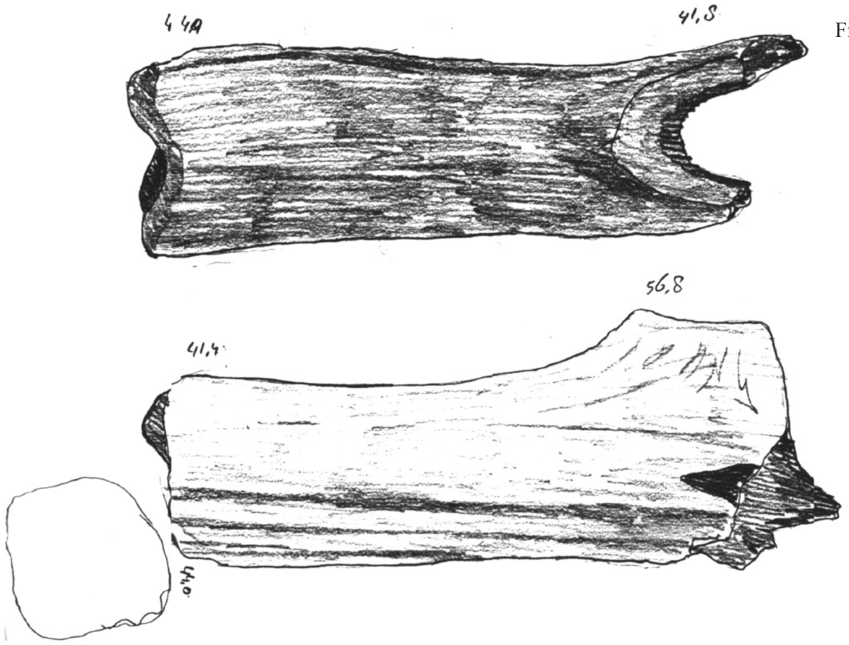


Fig. 5 T-axe No. 7411.

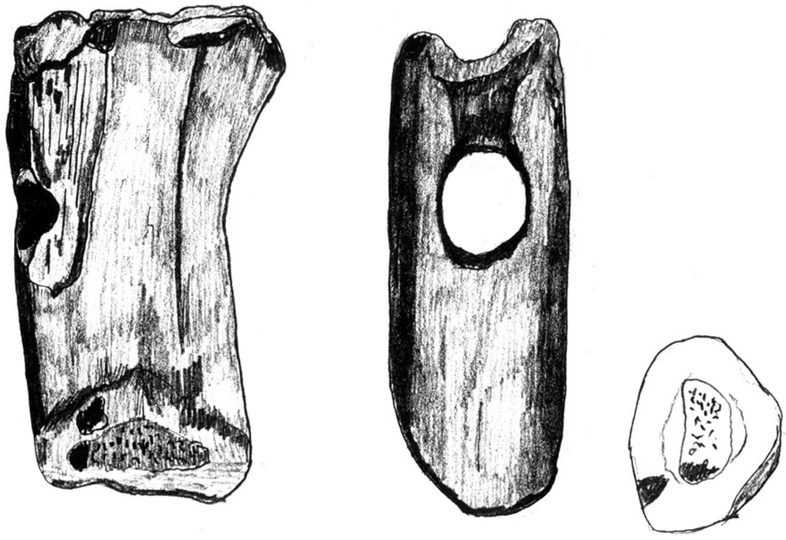


Fig. 6 T-axe No. 57445.

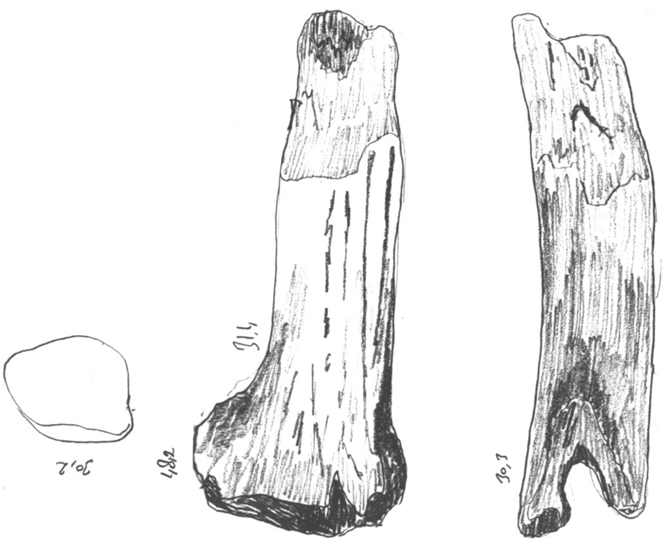


Fig. 7 T-axe No. 10194.

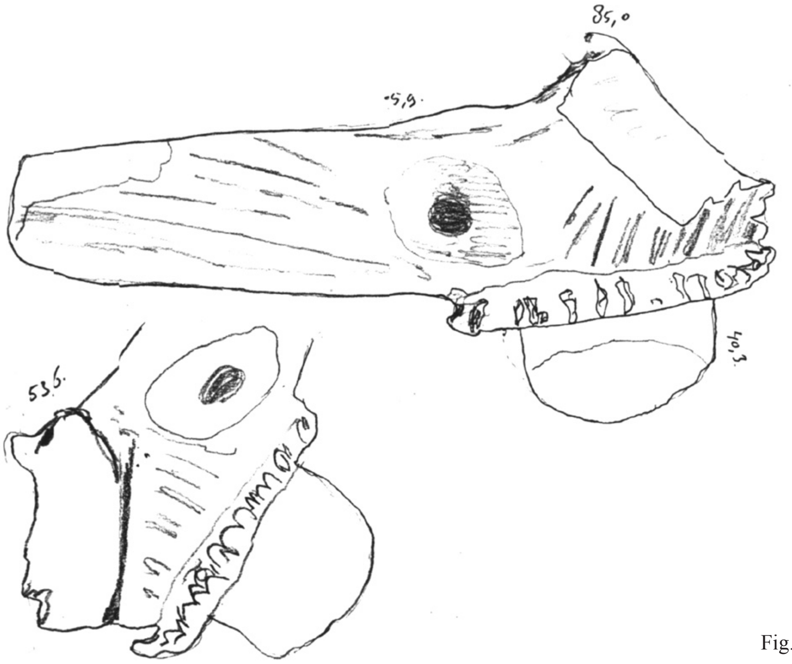


Fig. 8 Waste of T-axe manufacturing No. 910215.

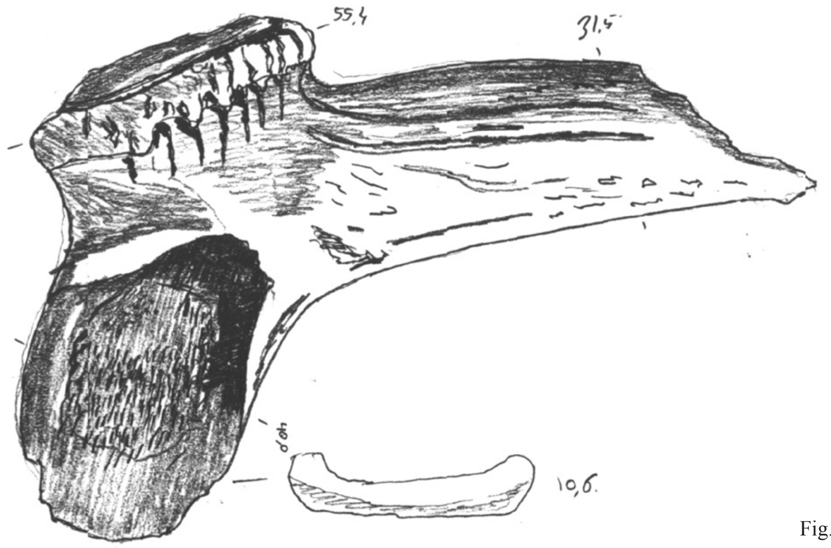


Fig. 9 Waste of T-axe manufacturing No. 910116.

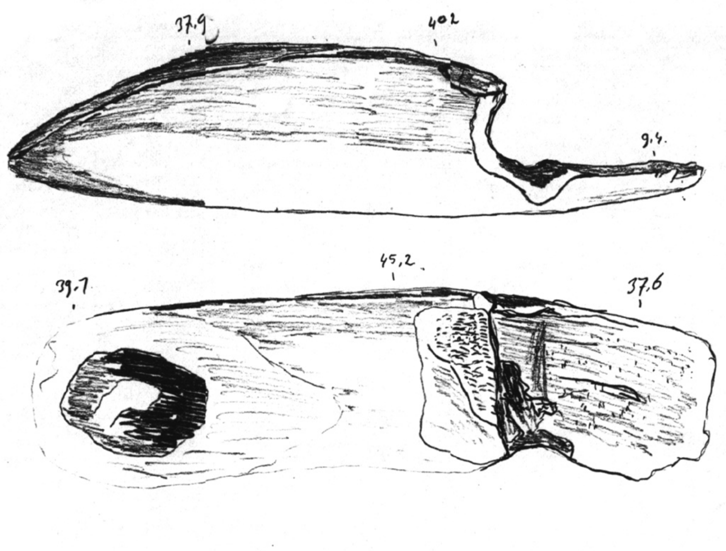


Fig. 10 Shafted axe, No. 53029.

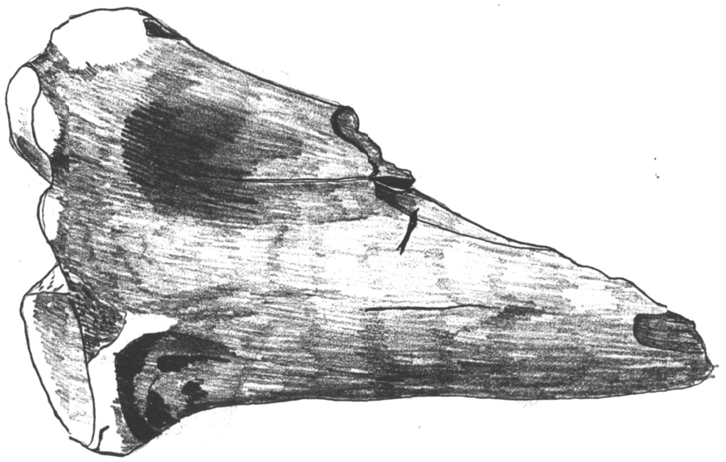


Fig. 11 Socketed axe, l. radius aurochs, No. 8088.

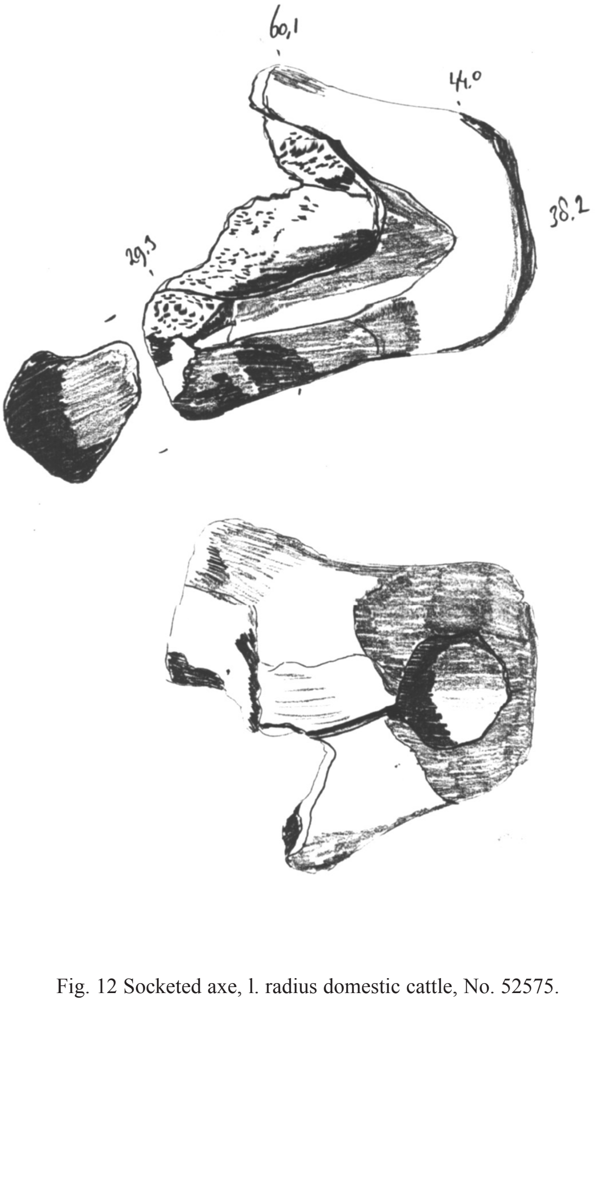


Fig. 12 Socketed axe, l. radius domestic cattle, No. 52575.

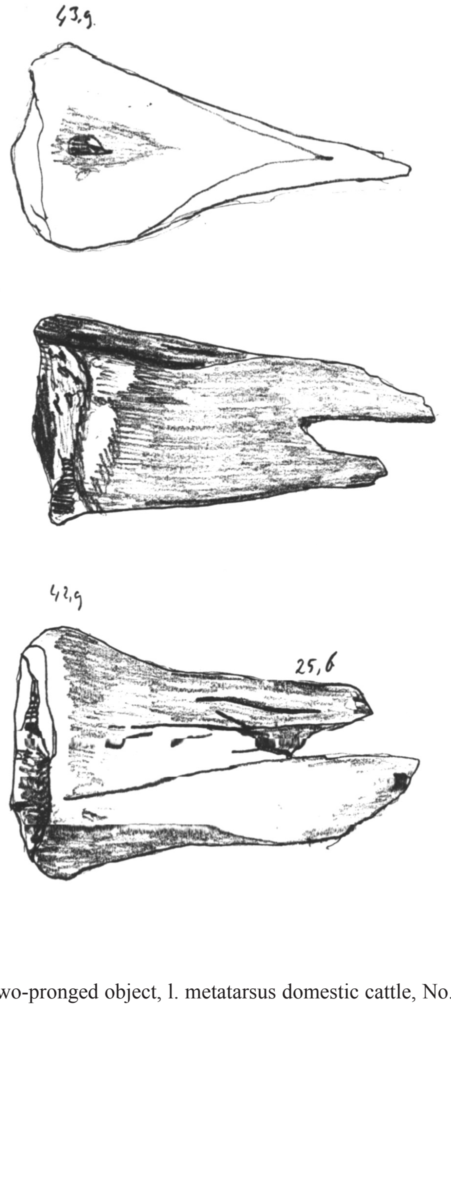


Fig. 13 Two-pronged object, l. metatarsus domestic cattle, No. 55007.

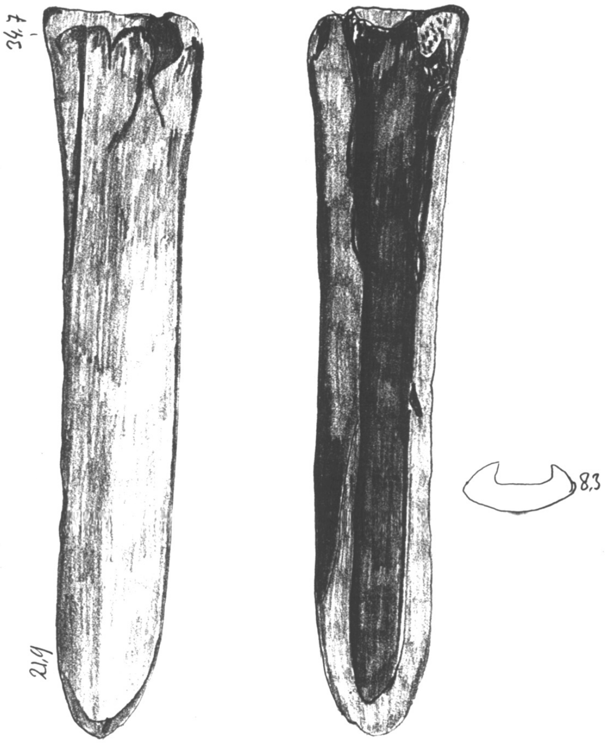


Fig. 14 Metapodium gouge, metatarsus *Bos taurus*, No. 31843.

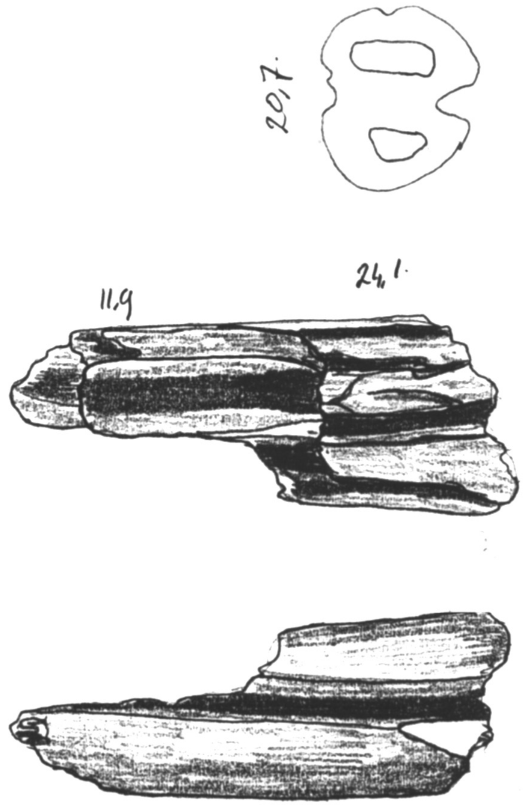


Fig. 15 Metapodium waste, No. 910221.

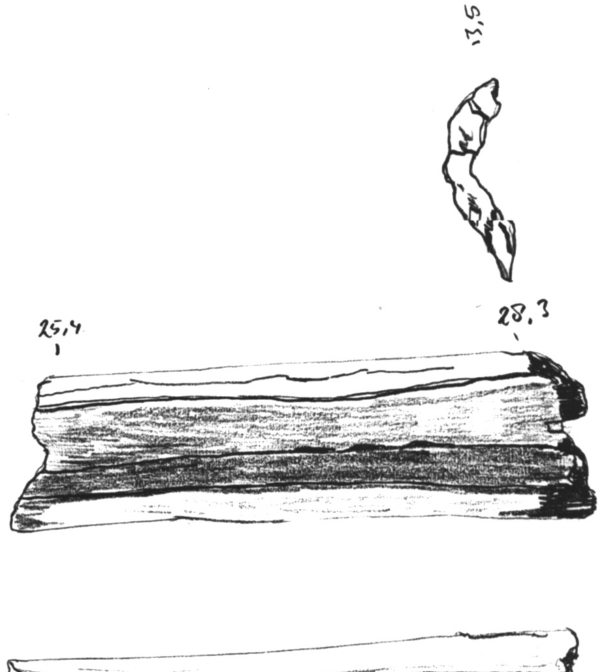


Fig. 16 Metapodium waste, No. 32458.

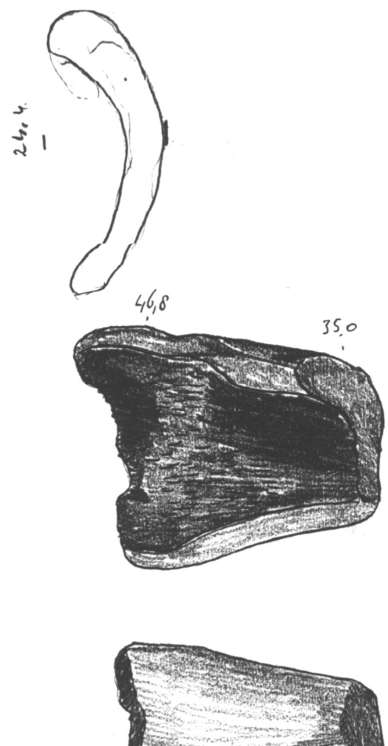


Fig. 17 Long bone gouge, No. 23040.

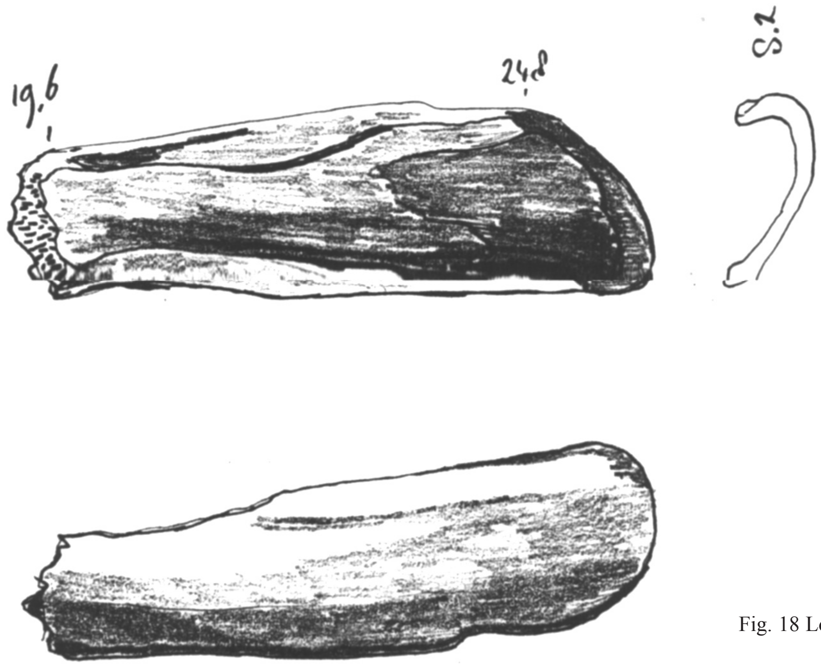


Fig. 18 Long bone gouge, No. 53285.

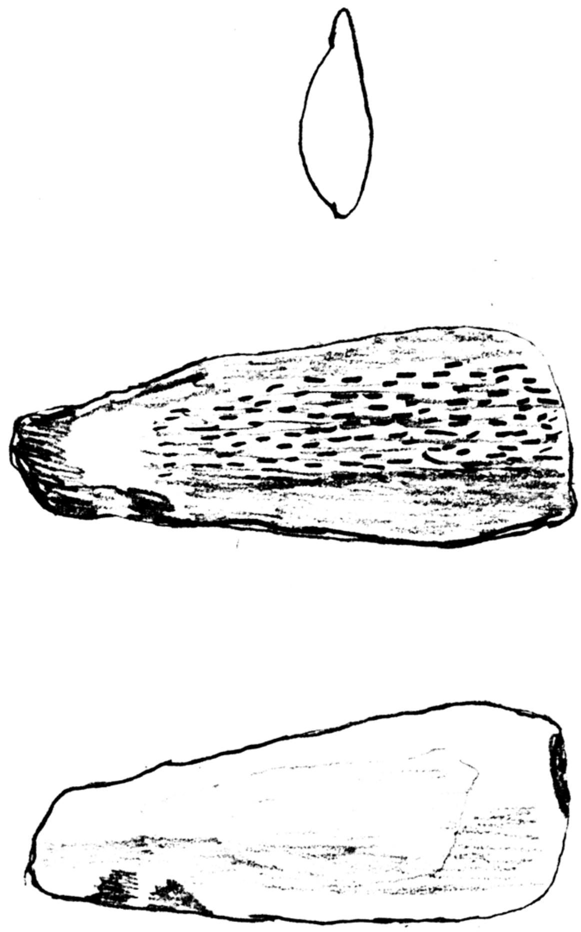


Fig. 19 Long bone gouge, No. 52952.

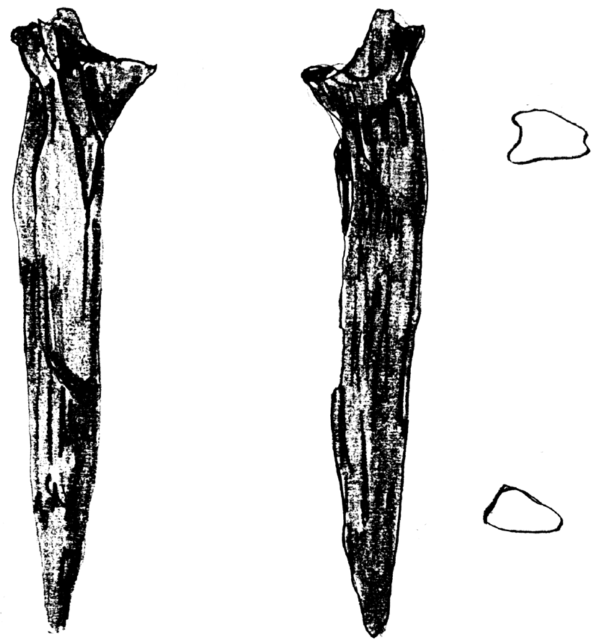


Fig. 20 Spina - *Silurus glanis*, No. 45949.

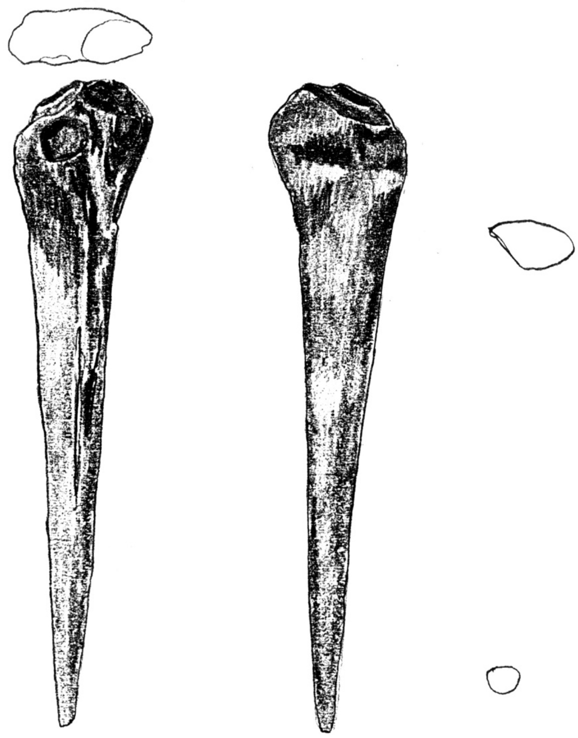


Fig. 21 Metatarsus II/IV - *Equus caballus*, No. 53887.

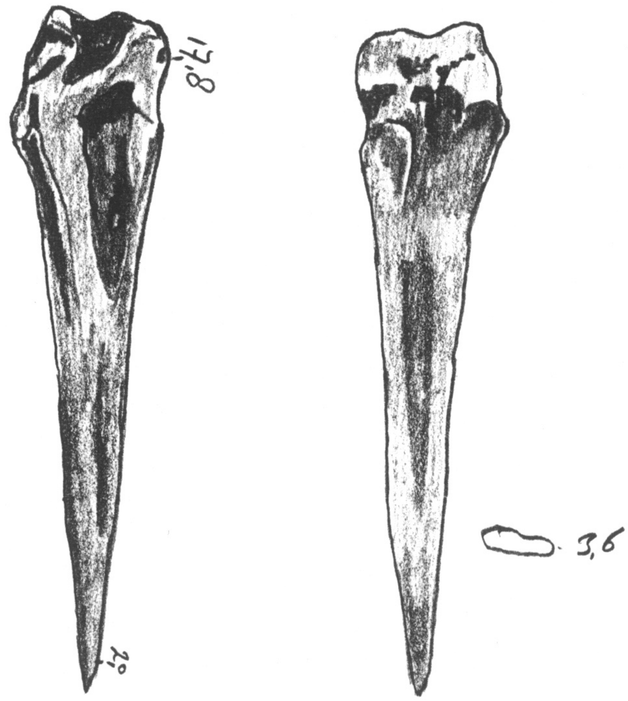


Fig. 22 Fibula - *Sus scrofa*, No. 57324.

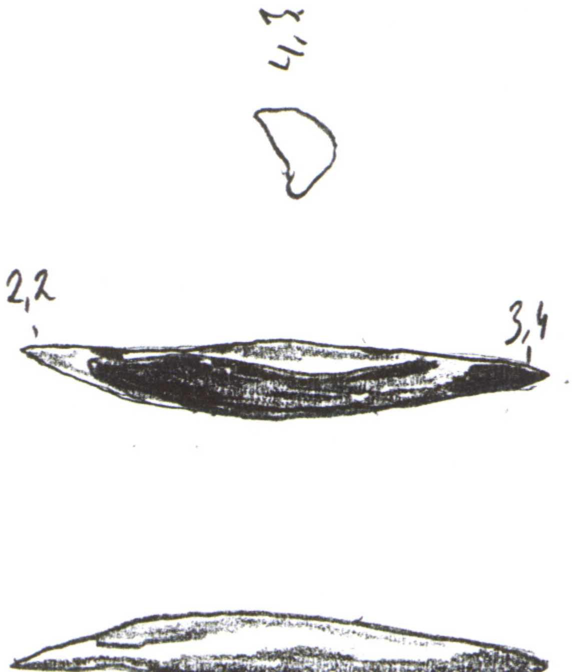


Fig. 23 Gorge, No. 35969.

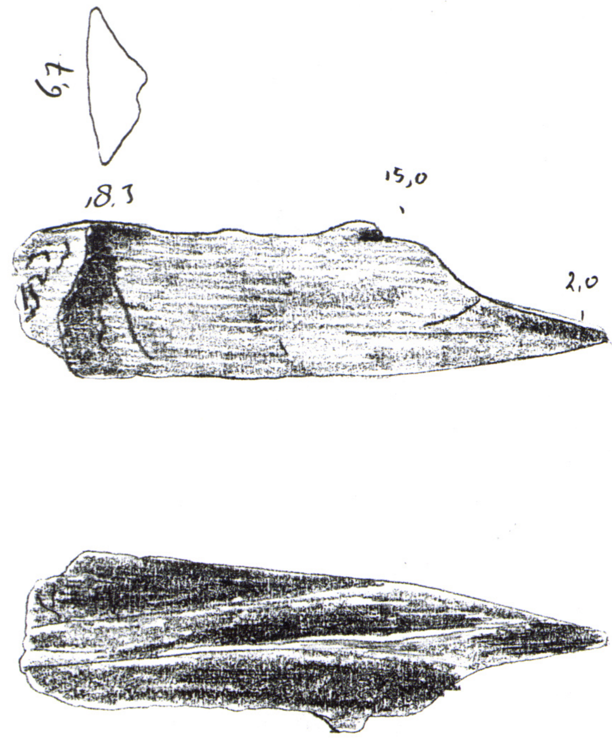


Fig. 24 Scapula - *Cervus elaphus*, No. 28600.

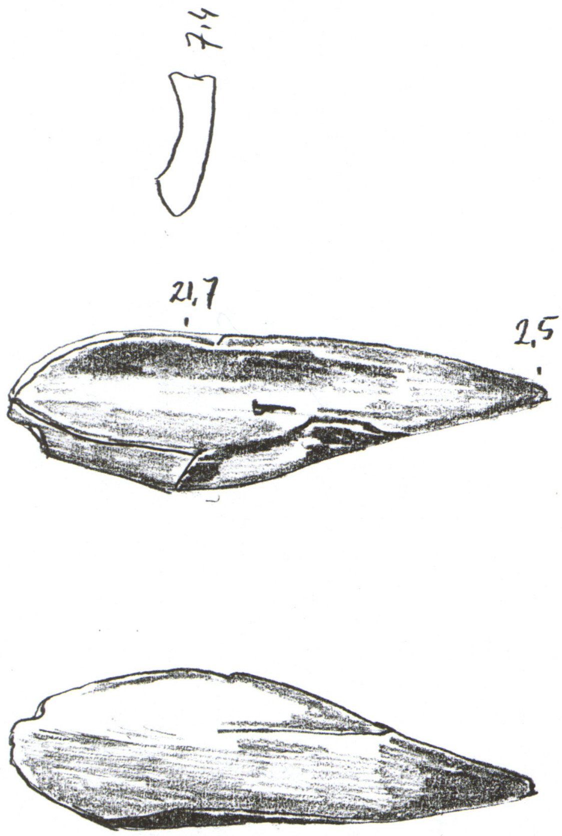


Fig. 25 Awl from long bone, No. 26402.

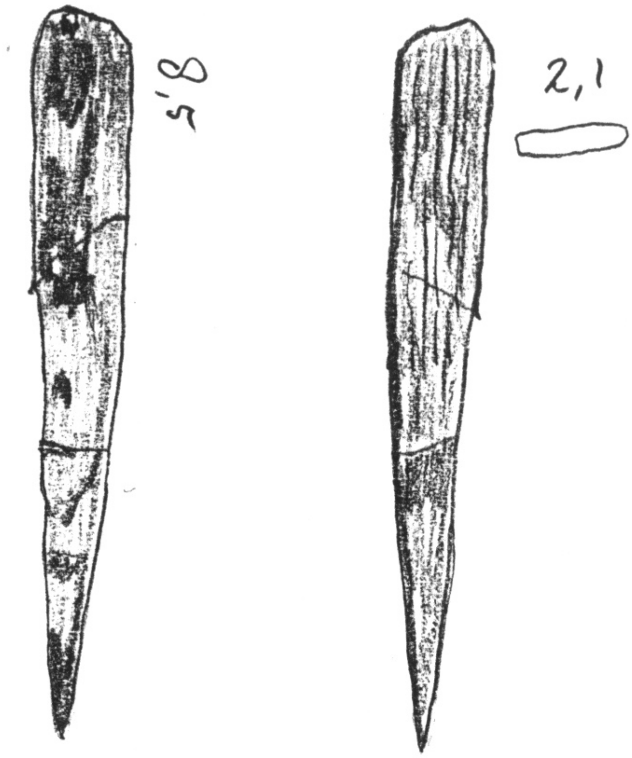


Fig. 26 Awl from long bone, No. 51540.

Fig. 27 Awl from long bone, No. 52102.

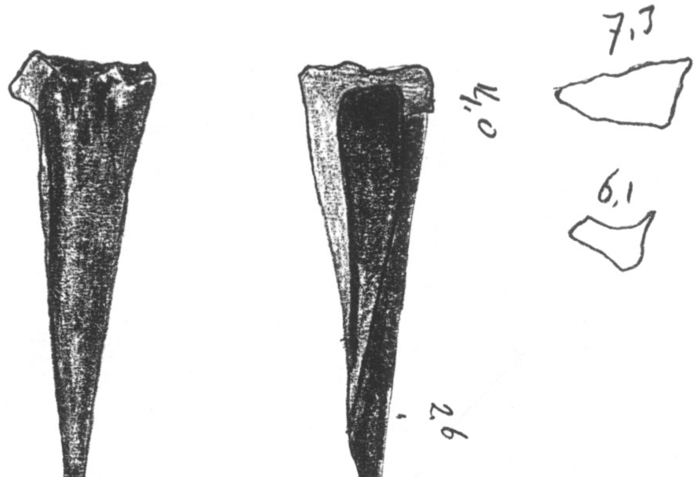


Fig. 28 Metapodium awl, No. 28260.

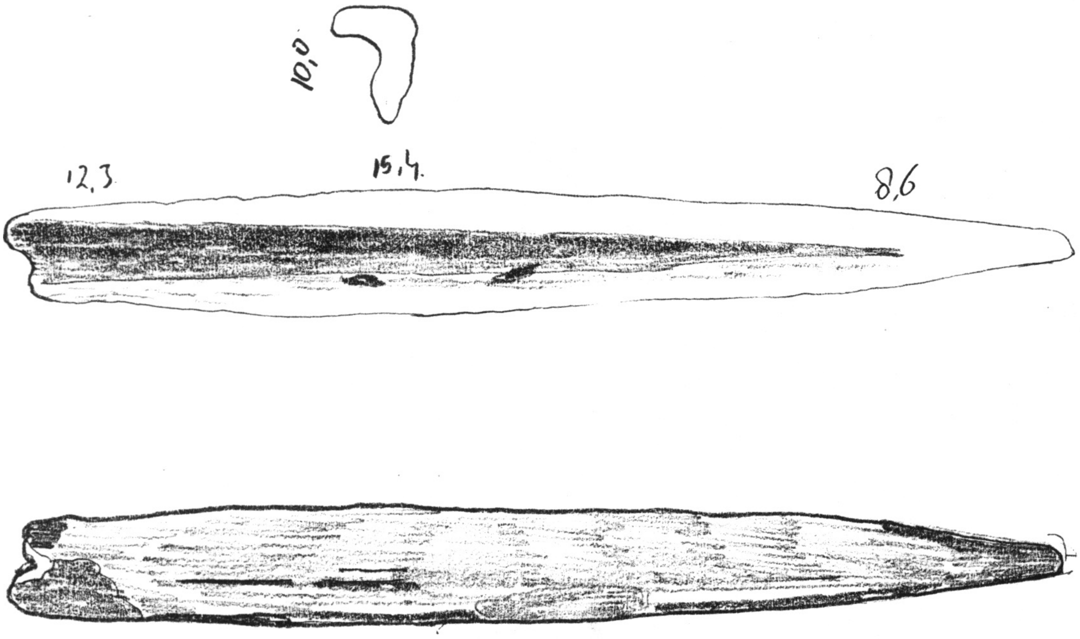


Fig. 29 Metapodium awl, No. 30704.

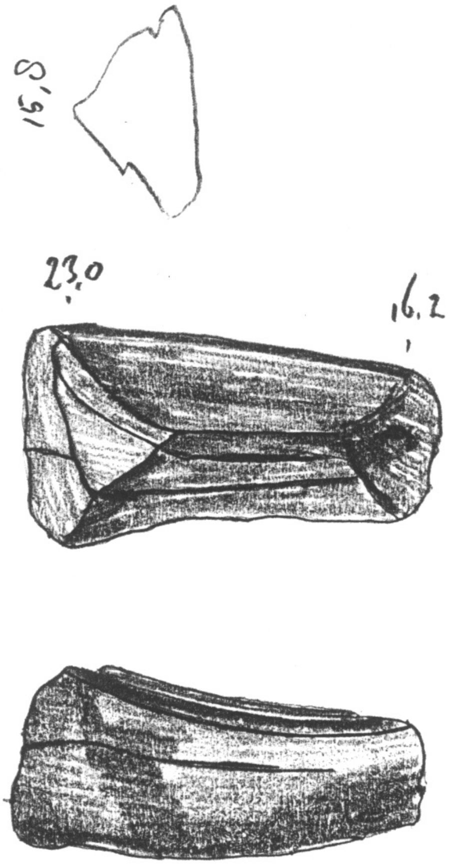


Fig. 30 Gouge C - *Sus scrofa*, No. 33156.

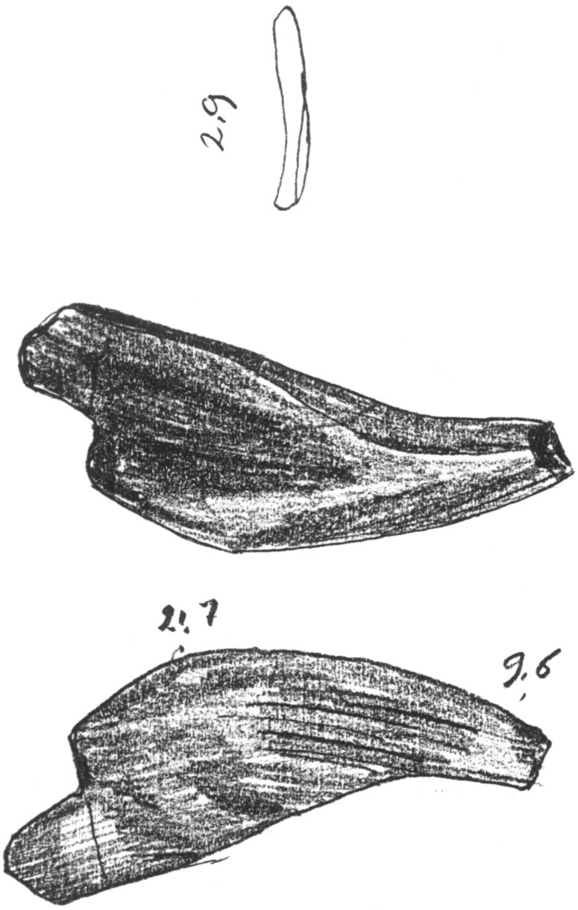


Fig. 31 Knife C - *Sus scrofa*, No. 16940.

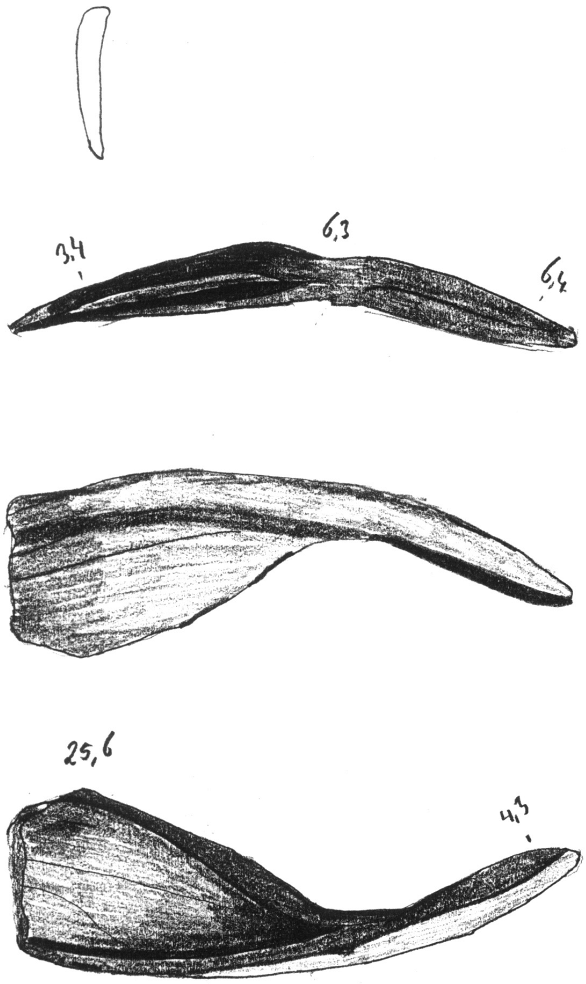


Fig. 32 Knife C - *Sus scrofa*, No. 39090.

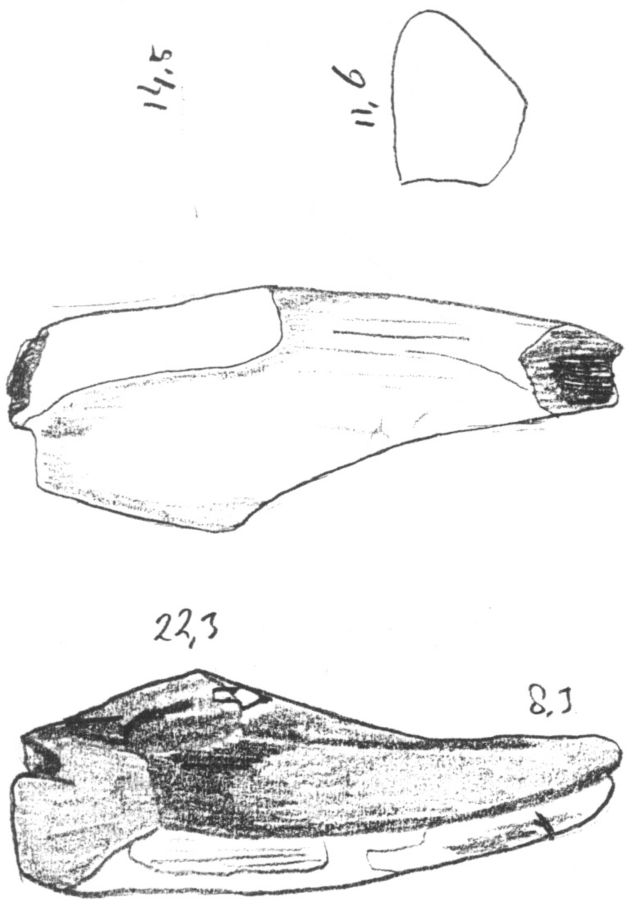


Fig. 33 Waste C - *Sus scrofa*, No. 39046.

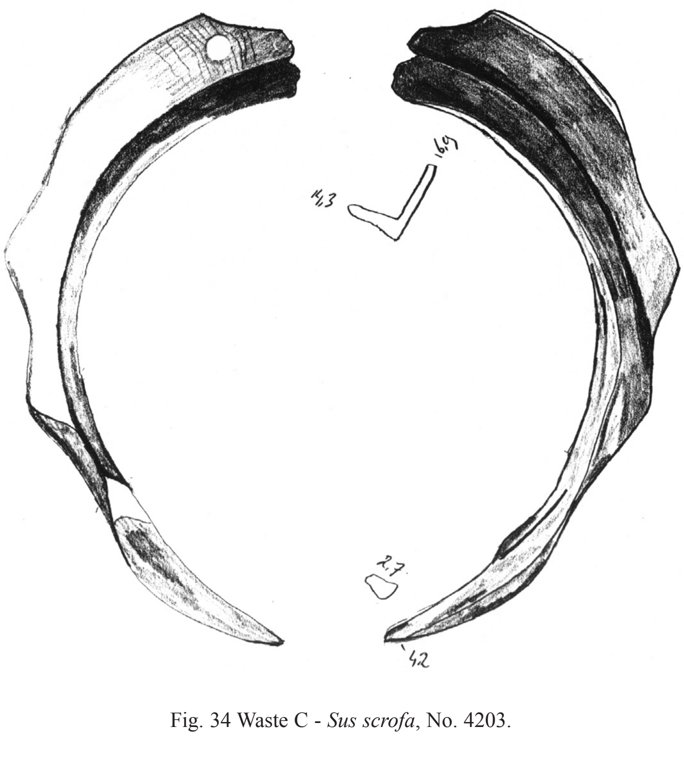


Fig. 34 Waste C - *Sus scrofa*, No. 4203.

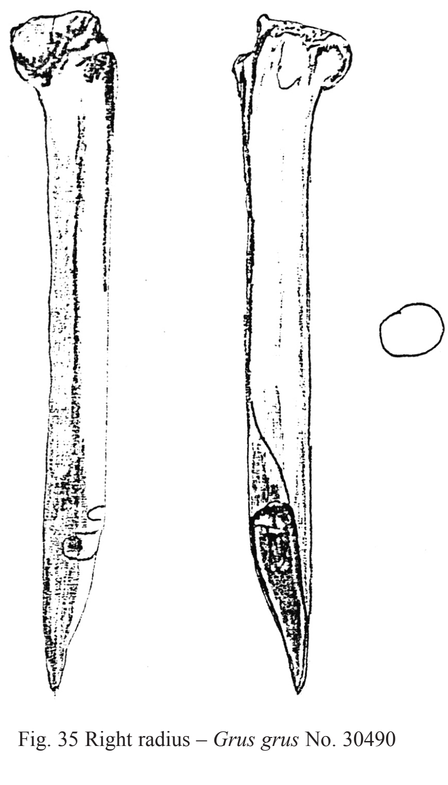


Fig. 35 Right radius – *Grus grus* No. 30490