*Bone and Antler**

Softening techniques in prehistory of the North Eastern part of the Polish Lowlands in the light of experimental archaeology and micro trace analysis

The aim of the analysis was to find out which methods of softening bone and antler were most effective when using stone tools. Four methods were analysed: immersion in water, boiling in water, soaking in sorrel and soaking in sour milk. The results of micro trace analysis carried out on the tools used in the experiments are presented, the aim being to compare the micro traces on the tools used to work the softened bone/antler.

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1. Introduction

One of the basic questions when describing organic artifacts is the way they were made. The reconstruction of the actions used to make them is without a doubt very important. It allows us to identify the techniques used and the way tools were operated to produce the items, this in turn gives us some information about the level of knowledge and skill of those who made them. How can we do this however when these artifacts have not been preserved? What, if we only have an assemblage of stone artifacts and a few cultural objects of unsure function? Experimental archaeology and micro trace analysis can be of great help here.

2. The goals of the article

The aim of this work is the presentation and analysis of some techniques for softening bone and antler, which could be available to those using these resources during the Stone Age as well as their verification during experiments.

This article has been divided into three parts. The first of these describes techniques for softening both materials. The second part of this work describes the results of a trace analysis which was conducted on the stone tools used in the experiments. The third part of this work was an attempt to identify softening techniques used in the Terminal Palaeolithic, Mesolithic and Neolithic periods in the north east parts of the Polish Lowlands. The issues addressed in this work are inseparably connected to the different ways of softening bone/antler in the Stone Age. The described methods for softening bone and antler are known from ethnographic parallels and archaeological experiments. The use of some of these is suggested by archaeological finds. The analysis was intended to identify the most useful method and to confront the results with evidence found on archaeological artifacts. This allows us to suggest the most likely used in prehistory.

3. Methods adopted

The work was based on two analytical methods: micro trace analysis on stone tools and experimental archaeology. For the purpose of micro trace analysis artifacts from 20 sites from the terminal Palaeolithic through to the Neolithic were used. Flint tools which were subject to microanalysis were first cleaned with pure ethanol. Tools used in experiments were additionally washed thoroughly with detergent. Steps were taken to make sure that as many "outside" factors were eliminated from the experiments as possible in order to make the results more representative and uniform in method. For all experiments un-retouched blades of similar length were used, all blades were struck off the same core of chocolate flint. The complexity of the process of making bone tools as well as the questions asked during the analysis conducted in this work imposed certain limitations. The treatment of bone and antler with the use of stone tools is a complicated process in which the stone tools are used in many ways. In order to produce more concise and clear results one of these actions had to be chosen, in this case it was sawing. The time of all experiments was also made uniform, one hour was accepted as sufficient to leave clear traces on tools. Similar rules were applied to bone and antler material, all antler came from one red deer shedding. All bone used during the experiment were fresh bovine tibias from one animal. All experiments were conducted by one person.

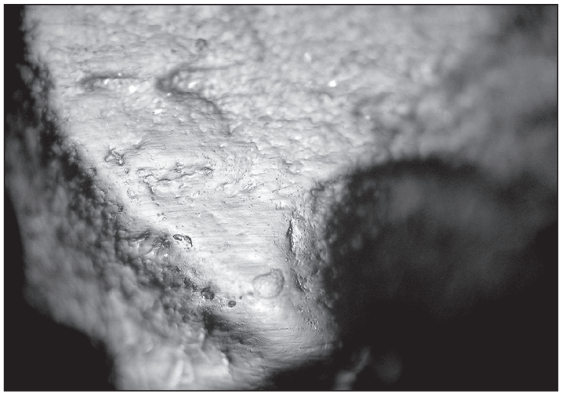
Each of the described methods was conducted separately for bone and antler.

■ **Photo 28** Bone and antler products made using flint tools and softening techniques.

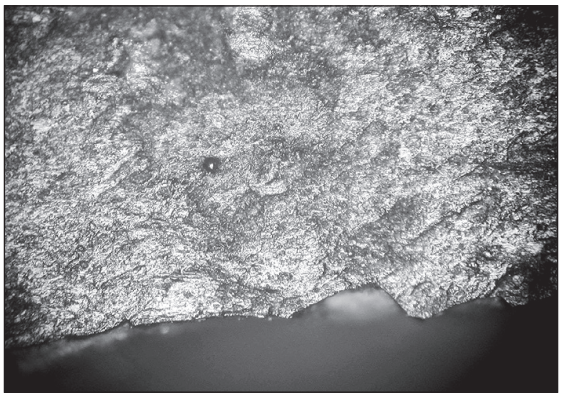
4. Archaeological finds

The majority of Stone Age bone and antler artifacts found so far, are finished or almost finished objects.

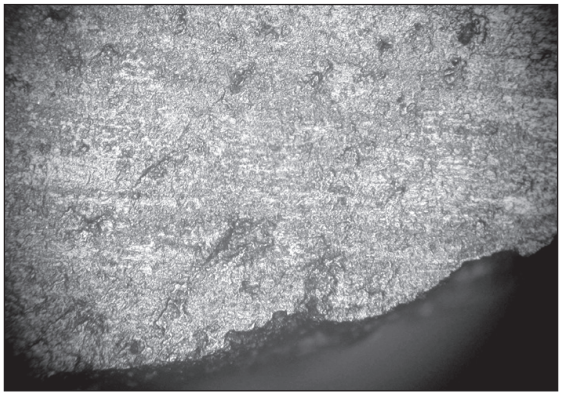
* This is a summarised version. For the full article with exhaustive notes please see www.eurorea.net.



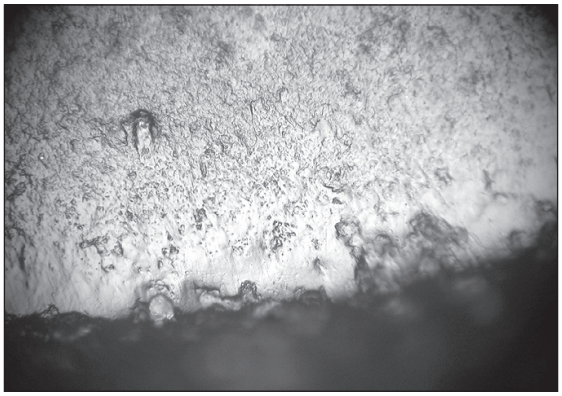
■ **Photo 8** Flint saw used on antler softened by immersion in sour milk (×250, ob. ×20).



■ **Photo 9** Flint saw for unsoftened bone (×125, ob. ×10).



■ **Photo 10** Flint saw for unsoftened antler (×125, ob. ×10).



■ **Photo 11** Flint scraper used on bone softened by acid from a sorrel mash (×250, ob. ×20).

They are usually well polished, which stops us from finding out how they were worked in earlier stages of their production. Others are half finished products in different stages of production. Usually they are covered with clearly readable cut and drilling marks, which are useful for defining the tools with which they were made. Of course they can help us to study only a small part of the production process. Even aligning a series of such artifacts in a technological line will not give as the full knowledge of the production process. This is because we can only see the "separate images" and not the whole "picture". We cannot say what was happening with the worked materials during the stages of production which are not documented on uncovered artifacts. Were they additionally worked in some way which is impossible for us to trace in present times?

The utilization of bone and antler softening methods in Stone Age is a matter of discussion. Even though a majority of researchers studying this problem have no doubt that such methods were employed (*Bagniewski 1992; Żurowski 1974; Kempisty 1961*), so far not one archaeological artifact, which could definitely confirm this has been uncovered. The form of uncovered items usually only suggests that it would be impossible to produce them without softening the raw material, first. Antler finds from Stellmoor A and Meindorf sites (*Lindemann 2000*) are the only artifacts which seem to be directly connected with softening of raw material. The antler deposits had been left in shallow water for the purpose of softening (Lindemann's interpretation). Another find which could be a direct proof of utilizing softening process in the Stone Age period, is the equipment of two burials from Władimicz (*K. Żurowski 1974*). The burials are dated as Upper Palaeolithic (*Renfrew, Bahn 2002*, 373). The skeletons were equipped with javelins made from mammoth tusks. The spearheads of both javelins were straight and utilization of softening technique seems to be necessary for achieving such results. Bone armlets are often associated with burials of Brzesko-Kuyavian Group of Lengyel Culture and are an example of a similar character (*Bednarczyk, Czerniak, Kośko 1980; Jażdżewski 1938*, 41-42; *Maciejewski 1952*, 187; *Rajewski 1958*, 30). These, usually beautifully decorated, items are often made of ox ribs (*Żurowski 1974*), which had to be bent to form the required shape. The degree to which the bones are bent suggests that this could not have been done without softening them first (*Jażdżewski 1938*). Such hypothesis has been confirmed by experimental investigation of K. Żurowski (*1974*), as well as by independent experiment of this article's author.

The above artifacts seem to be all of products which can directly confirm the utilization of softening technique in Stone Age period. Yet experiments suggest that practically all complex items made of these materials are a confirmation of utilization of this technique during this period. Most of them would simply be impossible to make with flint tools without softening bone or antler first. The effectiveness of flint tools working in unsoftened bone is decisive, as at the same time they are very suitable for working in softened material. Assuming that such a presumption is correct, we can state that the technique of softening bone and antler material was already known in Upper Palaeolithic period.

5. Methods of working antler and bone

Both bone and antler are hard and resistant materials. Therefore it is necessary to soften them. This process is not easy because the aim is not merely to soften the material but to make sure that when finished it will return to its normal hardness, durability and elasticity. Both bone and antler can of course be worked without softening but this is very hard and time consuming work.

The most commonly mentioned methods are immersing in water and boiling. More rarely mentioned is: softening in sorrel, sour milk, formic acid, ashes or lye, water with ashes, oil and, known only from ethnographic observations, in urine. In this work the focus was on four methods of softening antler and bone, and their usefulness in working these materials with flint tools.

Described here is the authors experience in softening these materials by: immersion in water, boiling in water, immersion in sour milk and immersion in diced sorrel.

5.1 Experiments with bone and antler softening

Working unsoftened bone and antler

The experiments were meant to demonstrate the difference between working softened bone/antler and material which had not been softened. The huge contrast between working quality of softened an unsoftened materials as well as the difference in the effectiveness may be a good starting point for discussion about bone and antler softening methods in prehistory. I haven't found any ethnographic examples of working untreated material with stone tools, but there are many experimental works on this subject.

Working bone and antler softened by immersion in water

This is one of the simplest bone and antler softening methods and also one of the lengthiest. It is simply the immersing of the material in water for many days. This technique has often been used in experiments which aim to reconstruct prehistoric softening methods of bone/antler (*Edholm 1999; Lindemann 2000; Wescott, Holladay 1999*). It is known from ethnographic observation. Until recently it was still being used by Caribou hunters from west Greenland (*Lindemann 2000*). It is also the only method of softening bone/antler which seems to be confirmed in archaeological material. Such suggestions have been made for finds from sites like Stellmoor A and Meindorf (*Lindemann 2000*). Some scientists maintain that it could have also been used in the Mesolithic (*Zhilin 2001*, 150). Its beginnings may have reached as far back as the upper Palaeolithic.

Working bone and antler softened by boiling in water

Boiling in water is a derivative of the method above, but it is less time consuming, which causes it to be among the most used methods of softening bone and antler (*Cnotliwy 1973*, 41; *Żurawski 1974*). It is thought of as one of the most useful, especially in the initial stages of working bone (*Tamala, Maldre 2001*, 372; *Watts 1999*). More over it is a method known from ethnographic observation. Until recently it was used by North American Indians (*Baales 1996*) and Asian peoples: the Czukcz, the Koriak and the Kamchedal (*Izjumowa 1949*, 19). Some scholars suggest that it was used in the Mesolithic (*Zhilin 2001*, 150). Boiling is the only bone/antler softening method described by ancient written sources, it was mentioned by Pausonius and Plutarch (after *Żurawski 1974*, 4). In Poland experiments with this method were conducted by W. Szafrański (*1961*, 44).

Working bone and antler softened by immersion in sorrel

Softening in diced sorrel is known only from experiments. The softening agent here is the acid which removes the inorganic parts. This process is supposed to turn the bone into a soft, elastic collagen mass, which is easy to work (*Kokabi 1994*). In Poland this method has been described by K. Żurowski (**1950**; 1974). He was the first and probably the only scholar so far to experiment in this area in Polish archaeology.

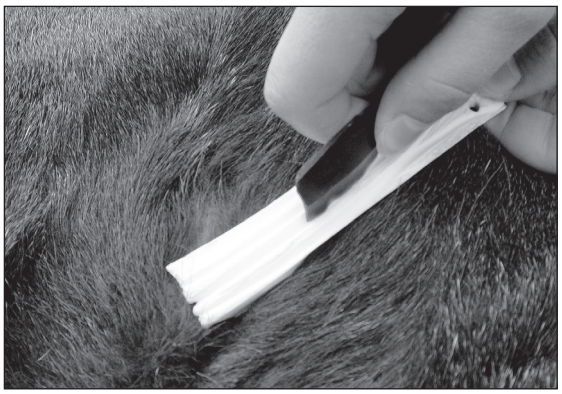
The sorrel used in this experiment had not been diced. Boiling water was simply poured on the sorrel which was than set aside for one week to sour. The materials were than put into it and left aside for a month. A litmus-paper measurement showed the sorrel to be pH 4.

Working bone and antler softened by immersion in sour milk

As with the sorrel method this one is also known only from experimental studies. In Poland experiments with this method have been conducted by K. Żurowski (*1974*). It is very similar to the sorrel method. The softening agent is the acid released while the materials are soaking in the milk.

The first experiments were only a partial success, although both the bone and antler was softened slightly. The softening effect was

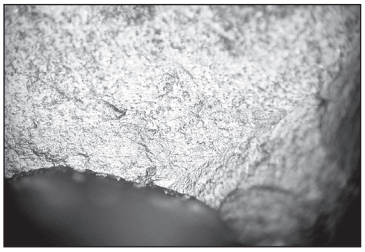
■ **Photo 22** Softening bones by boiling them in water.



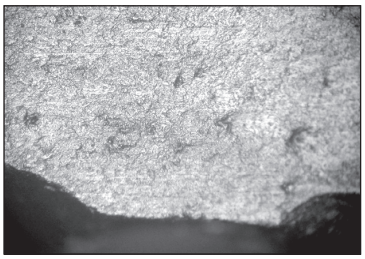
■ **Photo 23** Cutting bone with a flint blade.

■ **Photo 24** Whittling a softened antler.

■ **Photo 25** Polishing a bone needle on a sandstone slab.

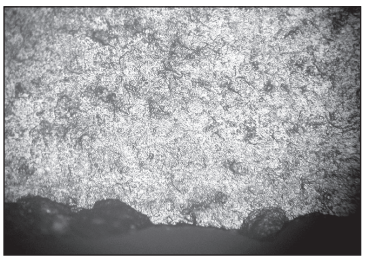


■ **Photo 1** Flint saw used on bone softened by boiling water (×250, ob. ×20).



■ **Photo 2** Flint saw used on antler softened by boiling water (×125, ob. ×10).

■ **Photo 3** Flint saw used on bone softened by immersion in water (×125, ob. ×10).



■ **Photo 4** Flint saw used on antler softened by immersion in water (×125, ob. ×10).

not a result of the milk. During the experiment the milk was tested several times with litmus-papers, but the pH proved to be close to neutral throughout the process, later it dropped but only to 5. After that it did not drop any further. The released acid was therefore too weak to soften bone or antler.

The failure of this part of the experiment was not due to poor quality milk, as all milk used in the experiment was fresh in order to avoid complications with processed milk. The time of the experiment also was long enough. The deciding factor was low temperature. Another problem was that the meat had not been cleaned off the bone carefully enough. Further experiments were conducted with a temperature of 25°C and the materials (bone) were first boiled and cleaned. Before the materials were immersed in the milk it was set aside for 5 days in 30°C temperature, which allowed full souring. At the moment of immersing the materials the pH of the milk was 4.

5.2 Conclusions

Working bone

All methods of bone softening described in this work have their advantages and their use makes working bone easier. Probably the best of the four methods is immersion in water. The only disadvantage is the long time needed, however it results in the bone been softened throughout its matrix.

Two methods come in second, boiling in water and immersion in sour milk. Boiling in water is a quick method, work can be started within a few minutes of when the water starts to boil. However, this method also has disadvantages: the softening effect is short lived and boiling only affects the surface. For these reasons the bone has to be reimmersed in boiling water often, which damages the material.

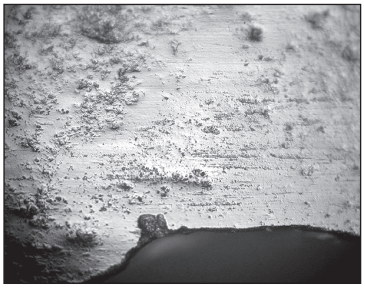
Immersion in sour milk is a very good method for softening thin bones, it allows you to bend the material. The disadvantage is that in the case of larger bones the effect is only surface deep.

Of the four methods immersion in sorrel seems to be least useful. The main advantage is that the softened bone is more elastic thus allowing you to bend it, however the list of disadvantages is long.

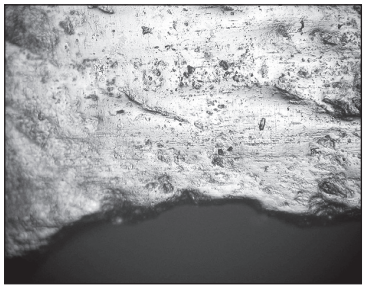
Working antler

On the basis of conducted experiments it is clear that antler responds differently to softening methods. Some techniques work better on bone than on antler and vice versa. In the case of antler there is no best method. All applied methods work well on this material. However there are some differences between them which allow us to distinguish the most useful techniques. The borders between the different methods are not as clear as with bone.

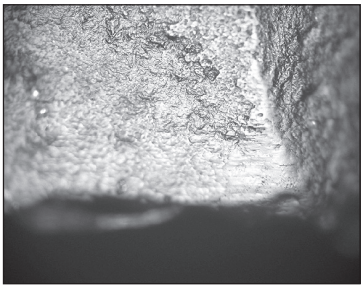
Probably the most useful methods for softening antler are long term immersion in water and boiling in water. As with bone the biggest advantage of boiling is the fairly short time necessary. The intensity of the achieved effect is also important, antler softens to a far greater degree than bone, although it requires longer boiling. The disadvantage again is the need to return the material to boiling water often.



■ **Photo 5** Flint saw used on bone softened by acid from a sorrel mash (×125, ob. ×10).



■ **Photo 6** Flint saw used on antler softened by acid from a sorrel mash (×125, ob. ×10).



■ **Photo 7** Flint saw used on bone softened by immersion in sour milk (×250, ob. ×20).

The biggest advantage of softening antler by long term immersion in water is the longevity of the effect as well as the depth of the effect. This method allows you to finish work on the material without additional softening.

Unlike bone, antler is better softened by immersion in diced sorrel than in sour milk. The basic disadvantages of immersion in diced sorrel remain the same as before, however it achieves a much more in depth and long term effect on antler than sour milk. Sour milk is only useful on antler if we are dealing with a thin sliver.

6. Wear traces on flint tools

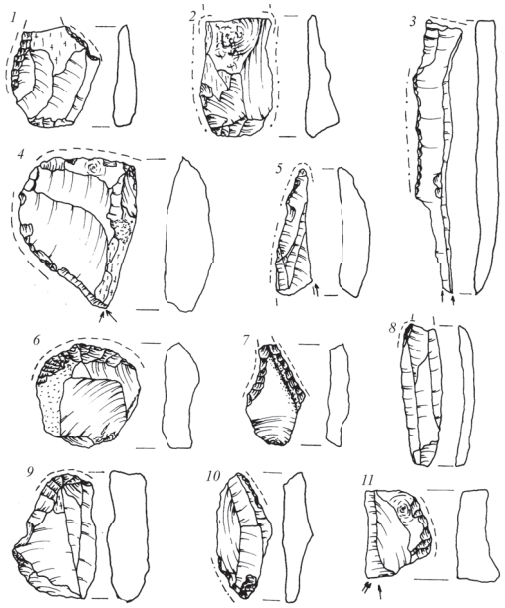
The aim of the analysis conducted was to characterize differences in the use wear traces on tools used for bone and antler, softened (or not) with different methods. The results will be used to help analyze prehistoric tools from archaeological excavations.

The analysis of use wear traces from the experimental flint tools has led to some interesting conclusions. First of all let's consider whether antler and bone should be treated as being the same in archaeological literature which talks about micro trace analysis. In the introduction to this work it has been pointed out that this approach to treating the two as the same was justified by the lack of differences between micro traces left by the two materials on flint tools (*Korobkowa 1999*, 44). It is a fact that both materials damage flint tools in similar ways and leave similar traces (retouch character, polish, and linear marks). However there are also some clear differences, most importantly antler damages flint to a lesser degree than bone. The retouch created is much more delicate and practically always one step. In the case of bone this retouch is much clearer and often multi stepped, micro hinges are also visible. Similar differences are visible in the character of the polish and the linear marks. In the case of antler the polish is usually faint and inline with the structure of the stone (**Photo 2, 4**). The linear marks in this case are practically not visible. In the case of bone the polish is clear and ingrained in the structure of the stone with very clear line marks (**Photo 1, 3**).

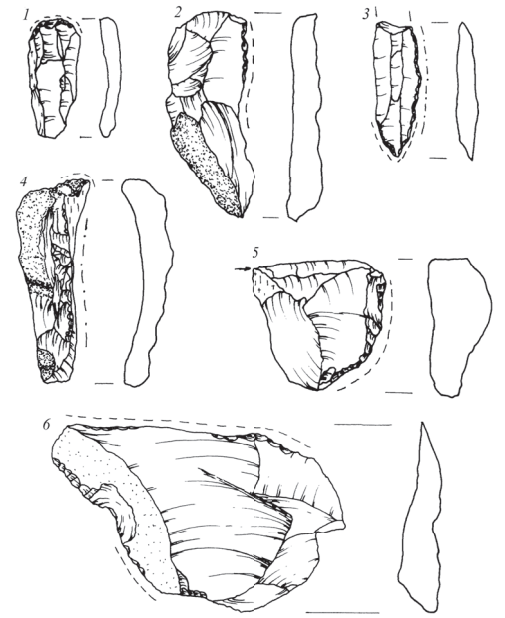
The next important question we need to ask is whether there is a possibility of telling apart tools used for materials softened by different techniques. This is important because it influences the type of questions which will be asked of the archaeological stone tool assemblage at the next stage.

Micro trace analysis of the experimental tools did not unfortunately point out a possibility for telling apart the different softening methods. The micro traces observed are very similar, it should be said that while in the experimental tools it was possible to tell apart the different softening methods, in archaeological material this would be practically impossible. Nevertheless trace analysis of the experimental tools has led to identification of some characteristic traits which might make this identification possible in the future. These traits do not apply to single methods but rather to certain groups of methods. Namely interesting differences have been noticed between the "water" methods and the techniques based on natural acids. The latter create a certain kind of polish on flint tools which is not created on tools used to work material softened in the water techniques. It is a very characteristic flat mirror like sheen (**Photo 5-7**). It has been observed that this sheen is created fairly quickly and is characteristic enough that it should be possible to identify on archaeological artifacts. Here however it has yet to be found. This could be for one of two reasons: either sorrel/sour milk was not used in prehistory to soften bone and antler, or it is due to the state of study, i.e. not enough trace analysis has been made so far.

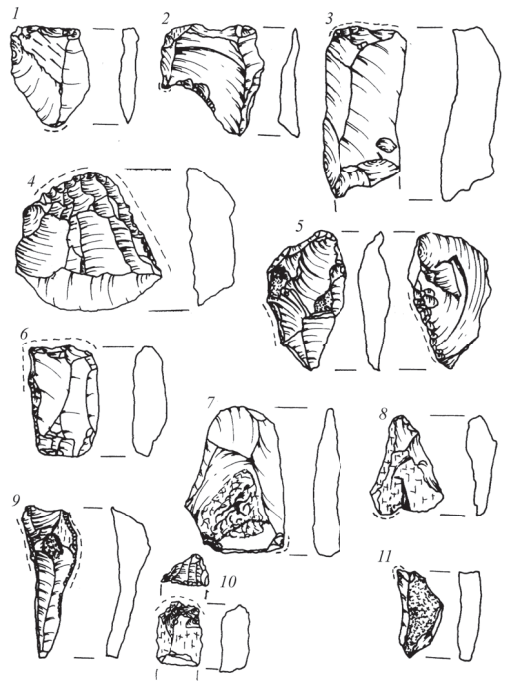
As has been noted already, trace analysis does not make it possible to identify the individual softening methods used on bone and antler. It should however be quite easily possible to identify whether a tool was used in softened or unsoftened material. Unsoftened material leaves a multi level retouch on the tool working it and destroys the working edge entirely.



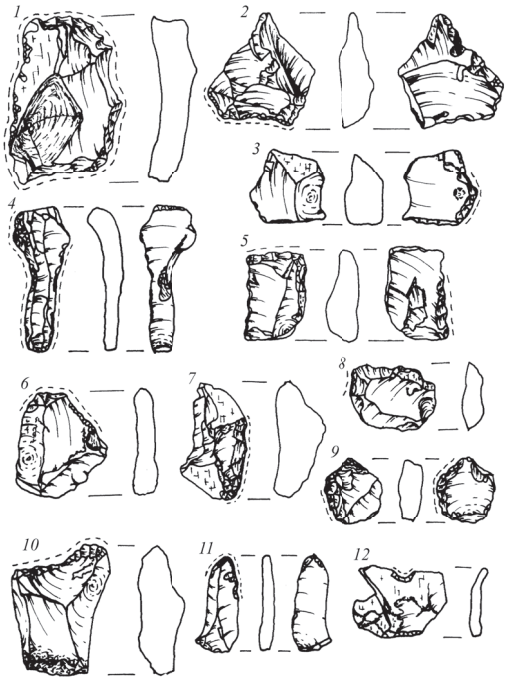
■ **Fig. 2** Stare Marzy, comm. Dragacz, site 5. A selection of Late Paleolithic tools used to work bone/antler. Scraper for unsoftened bone/antler (1, 4, 6); scraper used for softened bone/antler (5, 9-11); borer for unsoftened bone/antler (7); awl used for softened bone/antler (8); dual function tools: scraper used for softened bone/antler -•- (2, 3, 10) and: awl for softened bone/antler --- (2), hide scraper --- (3, 10).



■ **Fig. 1** Stare Marzy, comm. Dragacz, site 5. A selection of Late Paleolithic tools used for bone/antler working. Scraper used for softened bone/antler (1); scraper used for unsoftened bone/antler (2, 5-6); dual function tools: scraper -•- and borer --- used for unsoftened bone/antler (3); dual function tool: scraper for unsoftened bone/antler -•- and hide scraper --- (4).



■ **Fig. 3** Sąsieczno comm. Obrowo, site 4. A selection of Mesolithic tools used to work bone/antler. Awl used for softened bone/antler (1, 7, 8, 11); awl used for unsoftened bone/antler (2); scraper used for unsoftened bone/antler (3, 4, 6, 9, 10); dual function tool: scraper/plane for softened bone/antler --- (5)



■ **Fig. 4** Lubicz comm. Lubicz, site 12, 13, 18. A selection of Mesolithic tools used to work bone/antler. Scrapers used to work unsoftened bone/antler (1,2,9,10); scraper used to work softened bone/antler (3, 5-8, 12); scraper/plane used for softened bone/antler (4); borer used for softened bone/antler (11).

7. Methods of bone/antler working in the Stone Age

Introduction

In this chapter Stone Age tools used in bone/antler processing have been subject to micro trace analysis. In contrast to the "experimental" part of the work, all functional tools used to work both bone and antler have been identified here. Saws are quite rare in archaeological finds, which forces us to use also other types of tools to build a reliable base for our conclusions. Therefore apart from saws: scrapers, burins, planes and borers were taken into account.

The fundamental aim of this part was the identification, within the analyzed archaeological material, tools which were used to work bone and antler.

A detrimental factor was the post depositional damage the artifacts have suffered. In some cases problems were also encountered because of the multi-functionality of some tools.

Some 183 tools, used to work bone/antler, from 20 sites were analyzed for micro traces. The sites represent a chronological range from the Terminal Palaeolithic through the Mesolithic to the Neolithic. All the sites are located in the north-eastern region of Poland and were excavated archaeologically.

Terminal Palaeolithic

Analysis was conducted on Terminal Palaeolithic artifacts uncovered on a Stare Marzy site (site 5, Dragacz commune, Kuyavian–Pomeranian voivodship; *Cyrek 2001, 2002*). The study takes into consideration 8 flint-concentrations uncovered (total of 1418 flint items). Micro trace analysis of those items has led to identification of 288 artifacts with traces of utilization, 43 of those were associated with the treatment of bone/antler. After taking into account the fact that some tools had more than one function, 47 tools underwent further analysis. Microscope analysis was conducted on: 30 scrapers, 1 plane, 3 borers and 13 burins. As a result 10 tools used to work softened bone/antler were identified as well as 17 tools used to work unsoftened material, wear traces visible on the other 10 tools were not clear enough to draw any conclusions. Among the tools used to work softened bone/antler scrapers dominated. Both on the scrapers and on burins working in softened material characteristic "bright" polish and linear marks were registered on the immediate edge which had contact with the worked material (**Photo 15**).

The retouch visible on them is one, two or in rare cases multi degree and the linear marks do not exceed the area of the bright polish. Tools classified as working in unsoftened material have in most cases a multi degree retouch, with a damaged working edge, functional retouch and faint polish on the edges. Linear marks do not appear at all or are represented by single scratches of differing width and length (**Photo 15**). Tools used to work softened bone/antler did not differ in form to those used in unsoftened material. In both cases fairly short blades were used. The analysis of the size of the tools suggests however that blades used to work in softened material were chosen with greater care. The size of the blades used to work softened material were very similar and practically standard, their length fitting in between 3 and 3.5 cm, while width is 2.3 cm (**Fig. 1.1; 2.1-3, 5, 8-11**). Tools used to work unsoftened material vary in size considerably (**Fig. 1.2-6; 2.1, 2, 4, 6-7**).

Analysis of micro traces on tools used for softened bone/antler did not allow a precise identification of the softening method used. We can with some certainty however exclude the use of natural acid techniques.

The Mesolithic

Micro trace analysis was conducted on 97 tools from this period. They came from four archaeological sites: Sąsieczno (commune Obrowo) site no. 4, Lubicz (commune Lubicz) sites no. 12, 13 and 18. Because of typological differences between the sites, Sąsieczno and Lubicz they will be introduced separately.

Sąsieczno, commune Obrowo, site no. 4

Two flint-concentrations were discovered on this site, producing 3723 flint artifacts. One of those scatters probably represents the remains of a partly sunken building, the other a seasonal hunting camp, both concentrations were well preserved. 386 items had use wear traces.

The micro trace analysis of Mesolithic flints found on this site has led to the identification of 61 tools used to work bone and antler. After taking into account tools with multiple functions this number rose to 65 tools: 35 scrapers, 6 planes, 6 saws, 14 burins and 4 borers. Further analysis allowed us to conclude that: 10 of these tools were definitely used to work softened bone/antler, 11 were probably used for softened material and 12 were used for unsoftened bone/antler. The traces found on 32 remaining tools were unclear. Tools used in softened bone/antler are particularly well worked. It's worth noting that burins formed almost one halve of all (securely identified) tools used to work in softened material. All burins used in softened material are "claws" (**Fig. 3.1, 7, 8, 11**). When you take into account the traces which registered on them (**Photo 17**), we suspect they were used to cut the material. Scrapers used to work the softened material are effectively the same in form as ones used to work unsoftened material. In both cases the working edge of the tool was re touched (**Fig. 3.3-6, 9-10**).

The analysis of the size of tools working in softened and hard material did not establish any major differences between them as in both cases we have examples of very large (**Fig. 3.3-4**), and small (**Fig. 3.10-11**) tools.

Lubicz, commune Lubicz sites no: 12, 13 and 18

1230 flint artifacts were excavated. Micro trace analysis identified 216 pieces with marks of being used, 36 tools were used to work bone/antler, 39 when we take into account multi functional tools. Among the tools analyzed were: 32 scrapers, 2 planes, 2 saws, 2 burins and 1 borer. As a result of the microscope observations the following have been identified: 12 tools which were definitely used in softened material, 9 tools which were probably used in softened and 8 tools used in unsoftened material. In 10 cases it was impossible to say.

In both softened and unaltered material the most numerous tool is the scraper. At first glance no major differences were noted between the two groups of tools apart from the micro traces. However a more detailed look at the tools has led to the discovery of some diversity between the two groups. Statistically speaking scrapers used to work softened material were made out of smaller blades of repetitive dimensions (**Fig. 4.3, 5-8, 12**). Scrapers used on unsoftened material are slightly larger (**Fig. 4.1, 2, 10**).

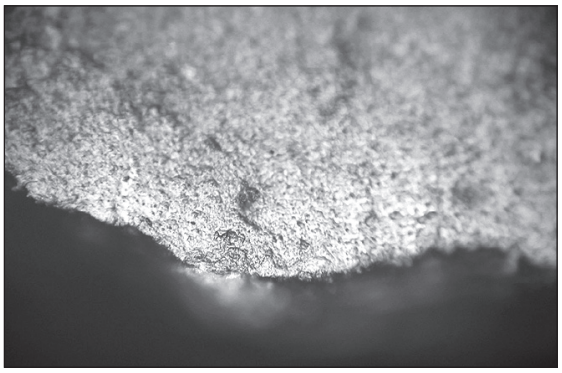
The analysis of the tools from Lubicz has shown some differences between them and the tools from Sąsieczno. The differences apply mainly to the polish. On the tools from Lubicz the polish is definitely less intensive, fainter and interferes less with the structure of the stone (**Photo 18**). These differences could be the result of the tools from Lubicz being less worked or it could be the result of a different softening technique. The current state of studies makes it impossible to draw a definite conclusion.

Conclusions

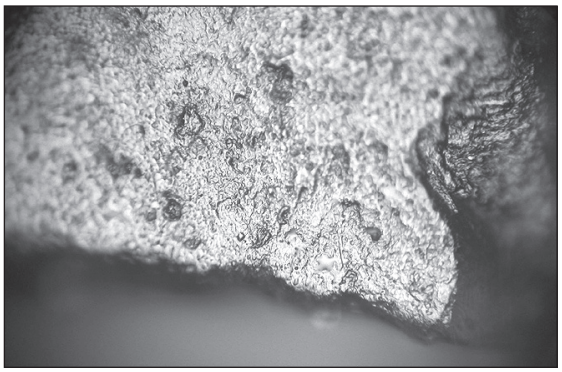
As it was suspected the analysis of the Mesolithic material did not allow for a certain identification of one of the bone/antler softening methods used in the Mesolithic. The results of the analysis from all four sites even seem to suggest that several softening methods were used. Similarly as with tools from the Terminal Palaeolithic the use of organic acid can probably be ruled out. Use wear traces from Sąsieczno point to the use of water soaking. On the tools from Lubicz a faint surface polish was present, which could be the result of working material softened by boiling.

The tools used to work bone/antler in this period were differentiated in type, form and size. However tools used to work softened mate-

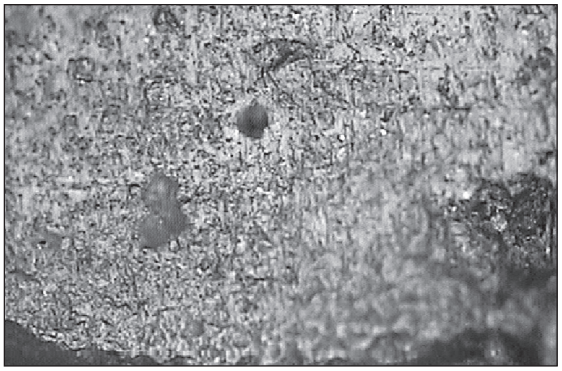
■ **Photo 12** Flint awl used on bone softened by acid from a sorrel mash (×250, ob. ×20).



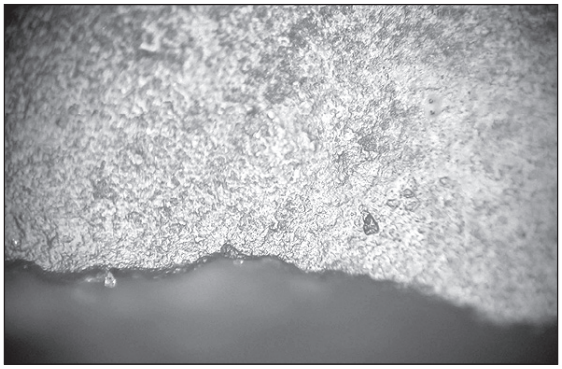
■ **Photo 13** Flint scraper used on antler softened by immersion in water (×250, ob. ×20).



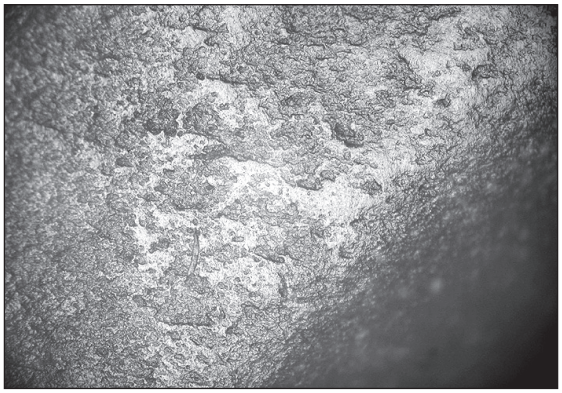
■ **Photo 14** Flint awl used on antler softened by immersion in water (×250, ob. ×20).



■ **Photo 15** Use ware traces visible on a Late Palaeolithic scraper used for softened bone/antler (×250, ob. ×20).

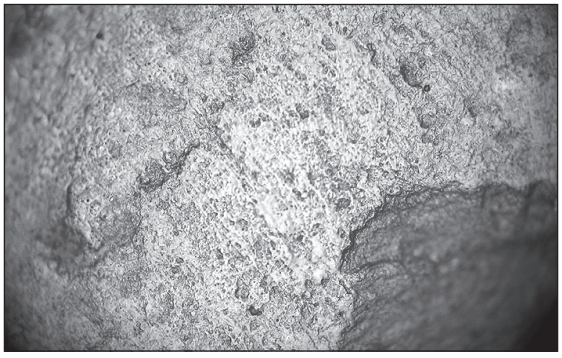


■ **Photo 18** Use ware traces visible on a Mesolithic scraper used for softened bone/antler (×250. ob. ×20).



■ **Photo 19** Use ware traces visible on a Neolithic awl used for softened bone/antler (×125; ob. ×10).

■ **Photo 20** Use ware visible on a Neolithic borer used for softened bone/antler (× 250, ob. ×20).



■ **Photo 21** Use ware traces visible on a Neolithic scraper used for softened bone/antler (×250, ob. ×20).

rials show a degree of standardization and are usually smaller. Bone and antler which were unsoftened were often worked with tools made out of random blades and varied in sizes and form. Some types of tools were attached to working one particular "type" of material. This is the case with "claw" burins from Sąsieczno. They were used predominantly to work softened bone/antler and were probably used for one function only.

Neolithic

Introduction

In this work tools from 15 different Neolithic sites were analyzed. These come from two different archaeological cultures: the Linear Band Pottery Culture and the Funnel Beaker Culture.

Linear Band Pottery Culture

Twenty tools from 5 different sites, including 1 with 2 functions, used to work bone/antler were analyzed. Among those tools were: 5 scrapers, 1 plane, 4 saws, 7 burins and 3 borers. Micro trace analysis of the above mentioned tools led to the identification of: 2 tools used to work softened bone/antler, 6 tools probably used to work softened material and 2 tools used in unaltered material. In 10 cases it was impossible to say.

The large percentage of tools which were impossible to analyze is due to the fact that most of them were not well worked. Usually only weak traces and a fine (but multi degree) retouch were visible. A faint polish was sometimes also recognized. Only in one case (burin) a clear and well developed bright polish (in places ingrained in the stone) and linear marks (**Photo 19**) were recognized. This artifact came from Annow (site no. 7) and was most likely used to work bone/antler softened by water soaking (this seems to be confirmed by the type of polish present) (**Fig. 5.1**).

A small amount (two examples, **Fig. 5.1, 2**) of the tools securely qualified as being used in softened material, did not mirror the intensity of the usage of the softening techniques used by the society of the Linear Band Pottery Culture. This might be the result of errors made during the first trace analysis of the flint tools included in this work.

Funnel Beaker Culture

In this group 29 tools used to work bone/antler including 5 multifunctional ones were analyzed, they came from 111 sites of the Funnel Beaker Culture. Among these the following were found: 11 scrapers, 1 plane, 12 burins and 2 borers. Trace analysis showed 6 tools used to work softened bone/antler. Another 4 tools were found which were probably used in softened bone/antler, 15 tools which were used in material which was not classified and 4 which were used in unsoftened bone/antler.

As with the tools from the Linear Band Pottery Culture it was impossible to determine the degree to which bone/antler was softened in the case of most tools analyzed. However without doubt softening techniques were known and used relatively often by the Funnel Beaker Culture. Tools used in softened material were found on most of the sites taken into account, and micro traces which are observed on them (**Photo 21**) suggest a relatively long period of usage. Among the tools which were used in softened bone/antler the borers deserve special mention (**Fig. 5.4, 5, Photo 20**).

Conclusions

Similarly to the Terminal Palaeolithic and the Mesolithic tools it was impossible to securely identify individual methods used to soften bone/antler in this period. However micro traces on the tools make it likely that "water" methods were used. Perhaps a repeated micro trace analysis of all the tools could make this hypothesis more likely, however this is impossible at the moment.

8. Recapitulation

Different methods of working organic material in the Stone Age are a very wide topic. Studies in this area are made difficult by the small amount of archaeological evidence,

they are also made more difficult by the lack of suitable analytical methods. In at least some of the problems experimental archaeology combined with micro trace analysis can be very helpful.

As was mentioned in the introduction: bone and antler working was a complex process, and the analysis undertaken in this work was only meant to shed some light on one stage of this process. Despite this many of the problems mentioned remain unsolved, and others remain only partially answered. Among the goals which have been achieved we can count:

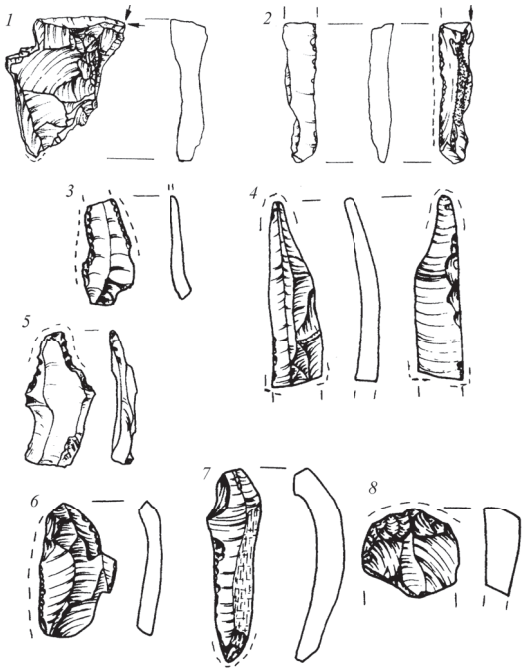
- The experiments have made it possible to describe characteristic marks left on tools used to work softened and unsoftened bone/antler.
- Micro trace analysis of the prehistoric artifacts has allowed the identification of tools which have been used to work softened materials, which confirms that bone/antler softening methods were known and used in the Terminal Palaeolithic, Mesolithic and Neolithic.
- The experiments have allowed some conclusions to be made about the methods of work and the way stone tools are damaged by working softened bone/antler. The experiments have also allowed some conclusions about the advantages and disadvantages of individual methods.

It was impossible to answer the basic question of what softening methods were known in the different time periods. Some suggestions however have been made which at this point seem likely.

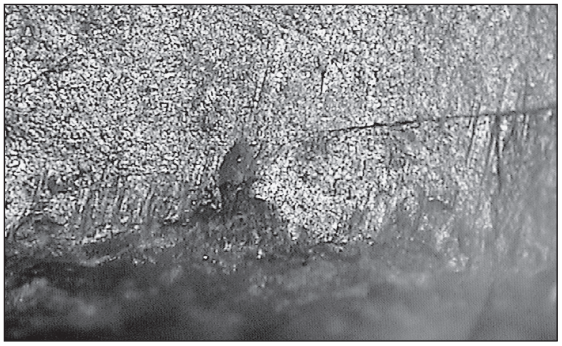
Several important questions regarding micro trace analysis as an analytical method were addressed in this article. As was shown some softening techniques cause the flint to wear in ways which are far from those thought typical of bone/antler working (Korobkowa 1999, p. 108) until now. Scientists using the classical set of traces may not identify these tools or may interpret them incorrectly. This problem needs further investigation.

Bibliography

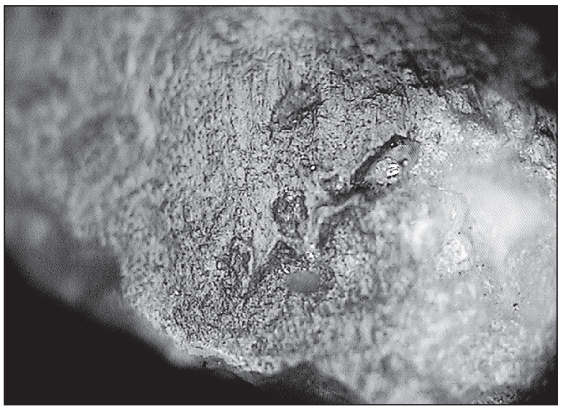
Anderson P.C., Beyries S., Otte M., Plisson H. (ed.), 1993: Traces et fonction: les gestes retrouvés, Liége.
Bagniewski Z., 1992: W sprawie obróbki surowca rogowego w mezolicie, Acta Universitatis Wratislaviensis, Studia Archeologiczne, tom 22, p. 13-33, Wrocław.
Baales M., 1996: Umwelt und Jagdökonomie der Ahrensburger Rentierjäger im Mittelgebirge. [w:] Römisch-Germanisches Zentralmuseum Monographien Band 38, Mainz.
Bartosiewicz L., Choyke A. (ed.), 2001: Crafting Bone: Skeletal Technologies through Time and Space, Oxford.
Bednarczyk J., Czerniak L., Kośko A., 1980: Z badań nad zespołem osadniczym ludności z kręgu kultur ceramiki wstęgowej w Kruszy Zamkowej, stan. 3, woj. Bydgoszcz, Sprawozdania Archeologiczne, tom XXXII, p. 55-83, Wrocław-Warszawa-Kraków-Gdańsk.
Budsławski J. Drabent Z., 1972: Metody analizy żywności. Warszawa.
Cnotliwy E., 1973: Rzemiosło rogowe na Pomorzu wczesnośredniowiecznym, Wrocław-Warszawa-Kraków-Gdańsk.
Comstock P., 1993: Bending Wood, [w:] Hamm J. 1993 (ed.), p. 155-167.
Cyrek K., 2001: Schyłkowopaleolityczne i mezolityczne osadnictwo w Starych Marzach st. 5, gm. Dragacz, woj. Kujawsko-pomorskie (na trasie budowy autostrady A1), Maszynopis opracowania w IA UMK.
Cyrek K., 2002: Paleolit schyłkowy i mezolit w dolinie Wisły pomiędzy Toruniem a Grudziądzem, w: Archeologia toruńska. Historia i teraźniejszość, p. 81-90, Toruń.
Edholm S., 1999: Making a reduced antler flaker, [w:] Wescott D. 1999 (ed.), p. 72-75.
Galiński T., 2002a: Społeczeństwa mezolityczne. Osadnictwo, gospodarka, kultura ludów łowieckich w VIII-VI tysiącleciu p.n.e. na terenie Europy, Szczecin.
Galiński T., 2002b: Przejawy sztuki mezolitycznej na ziemiach polskich, [w:] Sztuka pradziejowa ziem polskich. Katalog wystawy, p. 50-54, Gniezno.
Hamm J. (ed.), 1993: The Traditional Bowyer's Bible, Tom. II, New York.
Hilczerówna Z., 1961: Rogownictwo gdańskie w X-XIV wieku, Gdańsk wczesnośredniowieczny, z. 4, Gdańsk.
Hodges H., 1964: Artifacts. An introductionto EarlyMaterials and Technology, London.
Holm B., 1982: On making Horn Bows by Bill Holm, [w:] Hamilton T.M. 1982, p. 116-132, Columbia.
Inizan L., Roche H., Tixier J., 1992: Technology of Knapped Stone (Préhistoire de la Pierre Taillée; 3), CREP Meudon.
Izjumowa S.A., 1949: Technika obróbki kości w okresie diakowskim i w dawnej Rusi, Kratkije Soobszczenia, Nr. 30, p. 15-26, Moskwa.



■ **Fig. 5** Tools used to work bone/antler. The linear band pottery culture (1-3), funnel beaker culture (4-8). Awls used for softened bone/antler (1, 2), scraper used for softened bone/antler (6, 8) and for unsoftened bone/antler (3), and a borer used for softened bone/antler (4, 5, 7).



■ **Photo 16** Use ware traces visible on a Late Palaeolithic scraper used for unsoftened bone/antler (×125, ob. ×10).



■ **Photo 17** Use ware traces visible on a Mesolithic awl used for softened bone/antler (×250, ob. ×20).

Jażdżewski K., 1938: Cmentarzysko kultury ceramiki wstęgowej i związane z nim ślady osadnictwa w Brześciu Kujawskim, Wiadomości Archeologiczne, Tom 15, p. 1-106, Warszawa.
Kempisty A., 1961: Ze studiów nad sposobami obróbki surowca kostnego i rogowego w kulturze pucharów lejkowatych, Wiadomości Archeologiczne, tom XXVII, p. 133-143, Warszawa.
Kokabi M., 1994: Skelettreste als Rohmaterial – Material, Methode, Technik. „Knochenarbeit" Artefakte aus tierischen Rohstoffen im Wandel der Zeit. Archäologische Informationen aus Baden-Württemberg, Landesdenkmalamt Baden-Württemberg. Stuttgart.
Korobkowa G.F., 1999: Narzędzia w pradziejach. Podstawy badań funkcji metodą traseologiczną, Toruń.
Kukawka S., 1994: Sprawozdanie z powierzchniowych i weryfikacyjno-sondażowych badań archeologicznych na obszarze „toruńskiego" odcinka transeuropejskiej autostrady północ-południe (A1). Sprawozdanie złożone u wojewódzkiego konserwatora zabytków w Toruniu.
Łęga W., 1960: Okolice Świecia. Materiały etnograficzne, Gdańsk.
Lindemann M., 2000: Die Knochen und Geweihbearbeitung im westeuropäischen Jungpleistozän, [w:] Experimentalle Archäologie. Bilanz 2000, p. 7-28, Oldenburg.
Maciejewski F., 1952: Groby szkieletowe z młodszej epoki kamienia w Biskupinie, pow. Żnin (Stanowisko 15a), Z odchłani wieków, R. 21, z. 11, Wrocław.
Małecka-Kukawka J., 2001: Między forma a funkcją. Traseologia neolitycznych zabytków krzemiennych z ziemi chełmińskiej, Toruń.
Newcomer M., 1976: Experiments in upper palaeolithic bone work, CAMPS-FABER H., Méthodologie Appliquée A L'industrie De L'os Préhistorique –collogue international du CNRS n. 568, Senanque, 9-12 Juin 1976.
Owen L.R., 1993: Materials worked by hunter and gatherer groups of northern North America: implications for use-wear analysis. [w:] Anderson P.C., Beyries S., Otte M., Plisson H. 1993 (ed.), p. 3-15.
Pawlik A., 1993: Horn experimentation in use-wear analysis. [w:] Anderson, Beyries, Otte, Plisson 1993(ed.), p. 211-225.
Płonka T., 2003: The Portable Art of Mesolithic Europe, Wrocław.
Rajewski Z., 1958: 10000 lat Biskupina i jego okolic, Warszawa.
Renfrew C., Bahn, 2002: Archeologia. Teorie, Metody, Praktyka, Warszawa.
Szafrański W., 1961: Wyniki badań archeologicznych w Biskupinie, pow. Żnin, na stanowisku 6, [w:] Szafrańscy W, Z „Z badań nad wczesnośreniowiecznym osadnictwem wiejskim w Biskupinie, Wrocław-Warszawa-Kraków, p. 7-140.
Tamla Ü., Maldre L., 2001: Artefacts of bone, Antler and Canine Teeth among the Archaeological Finds from the Hill-Fort of Varbola, [w:] Bartosiewicz L., Choyke A. 2001 (ed.), p. 371-382.
Watts S., 1999: Bone working basic. [w:] Wescott D. 1999 (ed.), p. 62-65.
Wescott D. (ed.), 1999: Primitive Technology. A Book of Earth Skills, Salt Lake City.
Wescott D., Holladay D., 1999: *An Experiential Exercise With Bone [w*:] Wescott D. 1999 (ed.), p. 66-67.
Zhilin M. G., 2001: Technology of the Manufacture of Meszolithic Bone and Antler Daggers on Upper Volga [w:] Bartosiewicz L., Choyke A. (ed.), p. 149-156.
Żurowski K., 1950: Uwagi na temat obróbki rogu w okresie wczesno-średniowiecznym. Przegląd Archeologiczny, tom IX, p. 395-401, Poznań.
Żurowski K., 1974: Zmiękczanie poroża i kości stosowane przez wytwórców w Starożytności i we wczesnym średniowieczu, Acta Universitatis Nicolai Copernici, Archeologia 4, p. 3-23, Toruń.

Summary

Mots-clés: âge de la pierre, archéologie expérimentale, tracéologie, ramollissement des os et des bois.

Cet article présente notre travail d'analyse des méthodes de façonnage des os et des bois animaux pendant la Préhistoire. Cette étude nécessitait aussi de se pencher sur la technique de ramollissement de ces matériaux. Ainsi, l'expérience a été divisée en trois phases.

La première a été consacrée au façonnage de l'os et du bois, par le biais d'expérimentations archéologiques. La procédure spécialisée a permis une standardisation du travail et l'élimination des facteurs extérieurs influents.

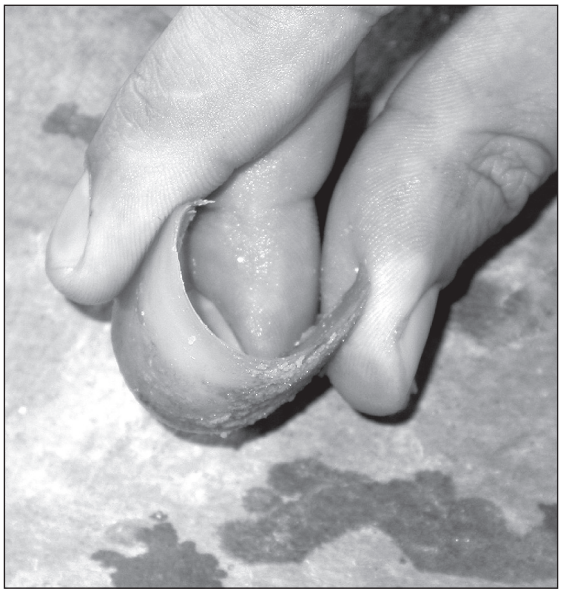
Des lames de silex brutes de longueur identique ont été utilisées sur des bois de cerfs et des tibias d'animaux (bétail). Le temps d'expérimentation a été fixé à une heure, lorque les outils ne s'usaient pas avant.

Cette expérience a permis de relever les facteurs de variables (comme le degré de déssechement, la dureté ou la fossilisation des os) qui ont un impact sur le résultat final.

Le choix des os utilisés dans cette expérience découlait du résultat de plus anciennes expériences. Si la structure est trop délicate, comme sur les côtes par exemple, l'usure est trop rapide.

L'expérience de l'artisan est aussi un facteur déterminant car plus il maîtrise son art et plus rapide et efficace est le travail. Cela a un impact sur les traces d'outil.

Différentes méthodes de ramollissement des os et des bois ont été expérimentées: trempage dans l'eau, cuisson dans l'eau, trempage dans une solution d'oseil haché



■ **Photo 27** Bending a softened bone.

■ **Photo 26** Shearing needles off a bone with an antler wedge.

et mouillage au lait acide. Certains os et bois ont été ramollis avant leur façonnage pour établir des comparaisons.

L'objectif était de relever les méthodes les plus efficaces pour le façonnage de os et bois animaux avec l'aide d'un outil en silex. L'observation des résultats suggère qu'à l'Age de la Pierre les méthodes de mollification des supports par bains d'eau ou par cuisson devaient être les plus utilisées.

La deuxième phase d'expérience portait sur l'analyse tracéologique des outils en silex utilisés lors de l'étape précédente et les micro-traces laissées sur les matériaux ramollis.

Dans un premier temps, la problématique a été abordée sous la forme de recherches bibliographiques sur de précedentes analyses tracéologiques. Une des hypothèses relevées propose que la méthode de façonnage est identique pour les os et les bois animaux en raison d'une absence de différence dans les traces d'outils. Cette argumentation est étayée par une analyse tracéologique d'outils créés expérimentalement.

Si les micro-traces sur les os et les bois sont identiques, il y a toutefois des différences visibles au niveau des retouches et des traces linéaires entre matériaux ramollis ou non.

Après ces recherches, une description des micro-traces a été faite, dont la comparaison permet de proposer l'hypothèse que les outils utilisés diffèrent si les matériaux ont amollis ou non. Il a été constaté que certains outils ne laissent pas de traces sur des matériaux mous.

L'analyse de ces traces prouve qu'il reste des problèmes dans l'identification des outils préhistoriques, comme par exemple ceux utilisés pour le travail du cuir ou la découpe de la viande. Ainsi, une partie des découvertes archéologiques reste encore mal identifiée. Quant-aux outils utilisés pour l'expérience sur les os et les bois, ils n'ont jamais duré plus d'une heure et il est croire qu'il en est de même pour la majorité des outils préhistoriques. Finalement, cette phase a révélé la méthode d'identification des méthode de ramollissement des os et des bois animaux sur la base d'analyses tracéologiques de vestiges.

La troisième et dernière phase du travail a été occupée par la reconstitution de techniques utilisées pour le façonnage de ces matériaux à différentes périodes : la fin du Paléolithique, le Mésolithique et le Néolithique. Cette analyse repose sur des études tracéologiques d'outils préhistoriques et sur des précedentes expériences. 183 outils en silex ont été analysés au microscope. Tous étaient utilisés pour le travail de l'os et du bois et viennent de vingt différent sites datés de la fin du Paléolithique à la fin du Néolithique du Nord-Est de la Pologne.

Pour la grande majorité de ces pièces, il a été possible d'identifier le façonnage d'os et bois ramollis ou non. Les traces usagères visibles sur ces outils ont été décrites et les différentes formes utiles pour le travail des matériaux traités ou non ont été identifiées.

Knochen und Geweih. Techniken zum Aufweichen in der Urgeschichte des nordöstlichen Teils des polnischen Flachlandes im Licht der experimentellen Archäologie und der Mikrospuren-Analyse

Das Ziel dieser Arbeit ist die Vorstellung und Analyse einiger Techniken zum Aufweichen von Knochen und Geweih, die während der Steinzeit angewendet worden sein können sowie ihr Nachweis durch Experimente an beiden Rohstoffen mit dem Einsatz von Flintgeräten.

Dieser Artikel wurde in drei Teile untergliedert. Der erste Teil beschreibt die Techniken des Aufweichens beider untersuchter Rohstoffe. Die Abfolge erlaubt eine Standardisierung der Arbeit und einen Ausschluss externer Faktoren. Flintklingen gleicher Länge wurden angewendet, um Geweih vom Rothirsch und um Langknochen vom Rind zu bearbeiten. Verschiedene Methoden zum Aufweichen wurden getestet: Kochen im Wasserbad, Einlegen in ein Wasserbad, Einlegen in Sauerampfer und Einlegen in Sauermilch. Die Absicht war dabei, die Effektivität der verschiedenen Methoden zum Weichmachen zu vergleichen. Die Beobachtungen legen nahe, dass es sich beim Einlegen und Kochen im Wasserbad um die wahrscheinlichsten in der Steinzeit angewandten Techniken gehandelt haben dürfte.

Der zweite Teil erläutert die Resultate einer Spurenanalyse, die bei den in den o. g. Experimenten verwendeten Steingeräten durchgeführt wurde. Das Ziel war es hier, die Unterschiede von bei der Bearbeitung durch auf verschiedene Weise aufgeweichten oder auch unbehandelten Knochen und Geweih entstandenen Gebrauchsspuren zu charakterisieren. Die Ergebnisse können bei der Auswertung von urgeschichtlichen Gerätefunden Verwendung finden. Die Analyse der Gebrauchsspuren von rekonstruierten Flintgeräten hat dabei einige interessante Daten erbracht: Zuerst ist zu fragen, ob Geweih und Knochen wie bisher üblich in der archäologischen Fachliteratur bei der Ansprache von Gebrauchsspuren gleich zu behandeln sind. Tatsache ist, dass beide Rohstoffe Flintgeräte in vergleichbarer Weise beschädigen und gleichartige Spuren hinterlassen (Retuschencharakter, Politur und lineare Einritzungen). Andererseits sind auch eindeutige Unterschiede zu erkennen, vor allem dass Geweih den Feuerstein wesentlich weniger beschädigt als Knochen. Die nächste Frage ist, ob es möglich erscheint, anhand der Gebrauchsspuren zu erkennen, auf welche Weise die Materialien aufgeweicht wurden. Die Mikrospuren an den Flintgeräten waren alle sehr ähnlich, aber es gibt ein wichtiges Unterscheidungskriterium: Durch die Anwendung von natürlichen Säuren kann eine besondere Art der Politur erkannt werden, die nicht bei Flintgeräten entsteht, mit denen Material bearbeitet wurde, das mit den Methoden des Aufweichens im Wasser erzeugt wurde.

■ **Photo 29** Bone arm-ring produced using softening techniques.

Der dritte Teil behandelt den Versuch, die angewendeten Aufweich-Methoden im Endpaläolithikum, im Mesolithikum und im Neolithikum in den nordöstlichen Bereichen des polnischen Flachlandes herauszuarbeiten. Auf Basis einer Spurenanalyse an 183 Flintgeräten aus archäologischen Befunden von zwanzig unterschiedlichen Fundplätzen Nordostpolens vom ausgehenden Paläolithikum bis in das Endneolithikum sowie der o. g. Resultate wurde dabei diese Untersuchung durchgeführt.

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