New insights on antler technology from Vučedol – Kukuruzište Streim

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The technology of processing hard animal material is an important segment in the study of prehistoric societies. This paper's main focus is on the exploitation of hard animal material, especially antlers from the Vučedol eponymous site (Late Copper Age). It deals with antlers as raw material, as well with the osseous industry of Vučedol culture, more specifically with its manufacturing technology. Findings from both old and recent excavations show well-known manufacturing techniques of processing osseous material. Interestingly, findings from recent excavations at Vučedol - Kukuruzište Streim show new elements in the manufacturing process – use of metal tools.

Keywords: *osseous material, antler, manufacturing technology, Vučedol culture.*

Introduction

Faunal remains had been an important part of prehistoric societies but they have also been severely neglected in archaeological studies. Recently, they have been given more attention and there is a growing number of papers concerning this particular subject. A better-suited term for faunal remains would be "hard animal tissues" (*matières dures animales)* because it includes bones and teeth, antlers and horns, ivory, molluscs and egg shells (Poplin 2004: 11; Sztancs et al. 2010: 40; Vitezović 2010: 23, 27), but most commonly used terms are "osseous

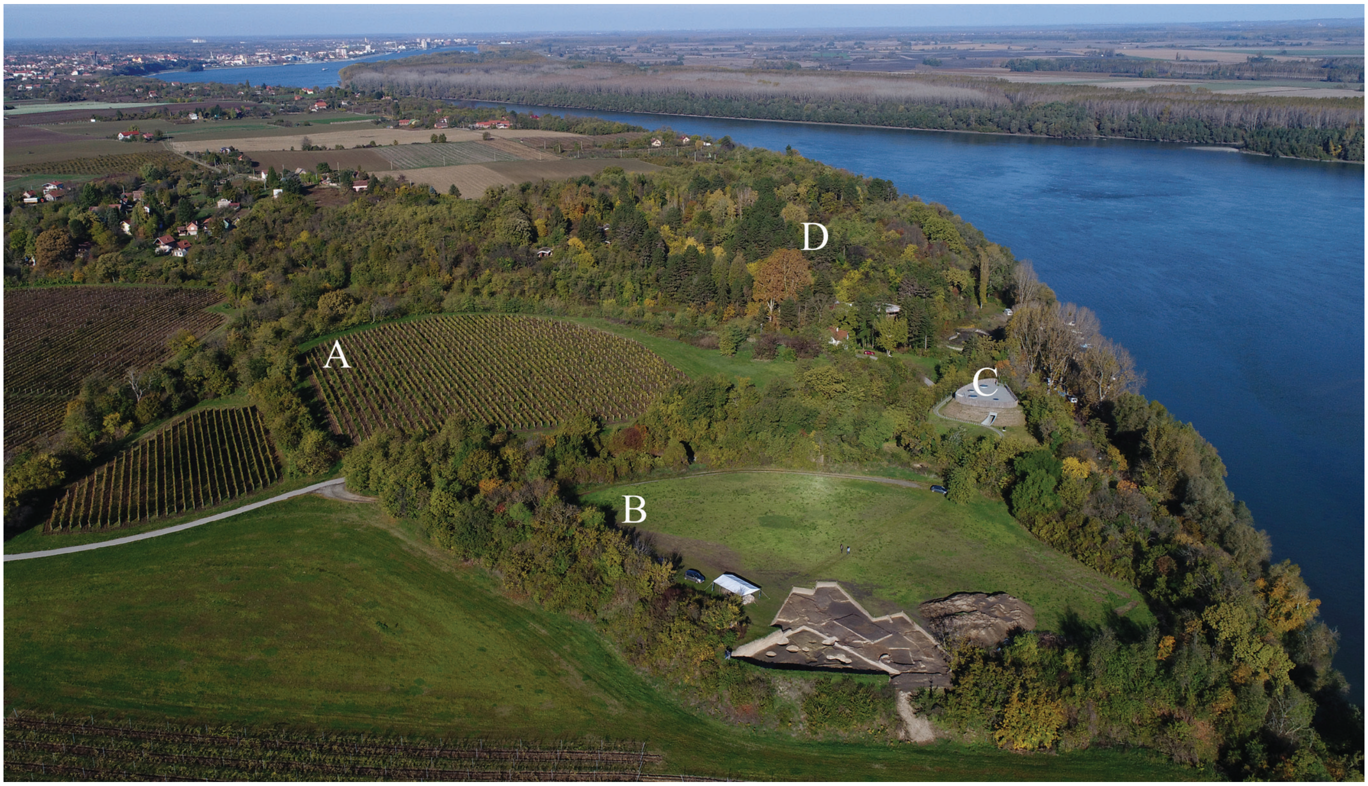

FIGURE 1. Vučedol site a) Vinograd (Vineyard) Streim b) Kukuruzište (Cornfield) Streim c) Gradac d) Vinograd (Vineyard) Karasović. (Vučedol Culture Museum photo archive)

material" and "bone material". Because of its characteristics, osseous material was used very early in human history and remained important even in later periods (Choyke 2010; Sofaer et al. 2013: 482). This type of material was widely available and accessible. Furthermore, it is extremely durable, well preserved in archaeological layers and suitable for making a wide range of artefacts ranging from functional to decorative and ritual pieces. Because of well-preserved osseous finds and traces left on them, we are able to gather information about everyday life in prehistoric societies, their manufacturing technology and even the function of the artefacts themselves. Osseous material has a key role in reconstructing and understanding manufacturing processes of organic material and it could prove the existence of various perishable technologies, activities and trades (Semenov 1976: 4-7; Choyke 1984: 14).

Vučedol site, research history and overview of available data

Vučedol site, situated on the right loess bank of river Danube near the town of Vukovar, is well known for its eponymous Late Copper Age culture. Vučedol culture dates between 3000 and 2400 BC (Durman and Obelić 1989; Horvatinčić et al. 1990; Forenbaher 1993: 247-48, Fig. 6). The eponymous site consists of four positions: Vinograd and Kukuruzište Streim (Vineyard and Cornfield Streim), Vinograd Karasović (Vineyard Karasović) and Gradac (Fig. 1). Its long research history started in the late 19th century with J. Brunšmids excavation of Vinograd Streim (Dimitrijević 1979: 267-70; Solter 2018). That excavation was followed by the famous 1938 campaign at Gradac led by R. R. Shmidt (Schmidt 1945). In 1960s S. Dimitrijević conducted excavations of all four Vučedol locations (Dimitrijević 1979: 267-80). Systematic and more extensive excavations started in 1984 at Vinograd Streim which were conducted by Department of Archaeology, Faculty of Humanities and Social Sciences of the University of Zagreb in cooperation with Vukovar Municipal Museum. Because of the Croatian War of Independence, excavations were stopped in 1991, continued later in 2001 and were finally completed in 2011 (Durman 1984; 1985; 1987a; 1987b; Durman and Forenbaher 1989; Durman and Balen 2005; Balen 2006; 2007; 2008; Durman and Hutinec 2011; Hutinec 2012). Excavations at Vinograd Streim proved that Vučedol culture occupied that position from its early to the late classical phase, known as phases A, B1 and B2 according to the periodization of S. Dimitrijević (Dimitrijević 1979; Balen 2018: 70). Most recent excavations are those of Kukuruzište Streim that had started in 2012. Although, two excavations were previously carried out, first by S. Dimitrijević in the 1960s and second by A. Durman in 1981 (Tasić 1995:170; Durman et al. 2013; 2014; 2016), they remain unpublished. Most recent systematic and rescue excavations of Kukuruzište Streim are being conducted by Department of Archaeology, Faculty of Humanities and Social Sciences of the University of Zagreb in cooperation with Vukovar Municipal Museum and Vučedol Culture Museum and are still ongoing (Durman et al. 2013; 2014; 2016).

There is a number of zooarchaeological studies conducted on the animal remains from Vučedol culture sites (Drobne 1964; Jurišić 1988a; Jurišić 1988b; Hincak 1995; Kosanović 1998; Kučera 1999; Kužir et al. 1997; Mihelić et al. 1998; Mihelić et al. 2013; Trbojević 1998; Tušek 2000; Trbojević-Vukičević 2002; Tušek et al. 2003; Trbojević-Vukičević 2006) but not many of them deal with archaeological aspects of the cultures osseous tools nor their manufacturing technology. Nevertheless, some attempts were made to incorporate these kinds of studies in overall publications of Vučedol culture sites (Dimitrijević 1956: 412; 1979: 314-15; Korošec et al. 1969: 18-19; Balen 2005: 56-58; Toškan 2009; Rajković and Balen 2016: 83-84; Vitezović 2018).

Antler and horn at the Vučedol site mostly derive from two families of *ruminantia* well known to European archaeology: deer (*Cervidae*) and cattle (*Bovidae*) (Cornwall 1964: 67; Kučera 1999: 6). Animal remains from few excavated sites in Eastern Slavonia and Western Syrmia show that most of the animal remains belong to domestic cattle (*Bos taurus*) which makes it the most common animal at analysed settlements and it is not surprising given that the animal husbandry is considered one of the bases of Copper Age economy (Jurišić 1988a; Jurišić 1988b: 24-25; Kosanović 1998: 18; Miloglav 2018: 120-121, 128). Large quantities of deer remains were found at two Vučedol settlements from Vinkovci. At Vinkovci - Tržnica approximately 33% of all animal remains belong to red deer (*Cervus elaphus*) and at Ervenica - M. Gupca 14 approximately 22 % (Jurišić 1988b: 24-25; Miloglav 2016: 130, Fig. 67). On the other hand, at Vinograd Streim red deer composes only approximately 9% of all animal remains (Jurišić 1988b: 24-25). Results from Tržnica are very interesting because wild animals remains compose half of all osseous remains (Jurišić 1988b: 24-25) which can be attributed to large areas of oak forests around Vinkovci region (Durman 2013a: 7-8, 10; 2013b: 17). However, remains of roe deer (*Capreolus capreolus*) from all three sites, were found in small percentages, ranging from 2.9 % found at Ervenica, 1.6 % at Vinkovci to 0.6 % at Vučedol - Vineyard Streim (Jurišić 188b: 25-26; Kučera 1999: 11; Miloglav 2016: 130, Fig. 67). Unfortunately, we don't have such information for Vučedol culture site Sarvaš whose name comes from the Hungarian word *szarvas* that means: the one who has antlers – deer (Choyke 2010: 24).

Mechanical and physical properties of osseous raw material

Horn and antler are significantly different. Horns are permanent paired hollow sheaths of keratin that arise from a spongy bony core anchored to the skull. They are usually present in both sexes of cattle and their various relatives (Cornwall 1964: 71-73; Kitchener 1987: 622; A. B. Bubenik 1990: 5). On the other hand, antlers are paired solid bony processes that arise from the frontal bone on the head of an animal of the deer family. They are usually borne exclusively by males with an exception of reindeers where both sexes have them. They are deciduous which means they are re-grown and shed each year and have a growth cycle that is closely associated with the reproductive cycle, hormonal processes and photoperiodism (Cornwall 1964: 67; G. B. Bubenik and Hundertmark 2002). During the first year of male cervids life permanent bony protuberances of frontal bones called "pedicles" are formed. From those two grown pedicels, antlers are later symmetrically formed and then shed (Cornwall 1964: 67; A. B. Bubenik 1990: 5). Antlers of different species slightly differ but are roughly the same in their anatomy (Cornwall 1964: 69-71, Fig. 10). Immediately above the pedicle is a bony rim of the antler base called "coronet" or "burr". When being shed antler detaches where the pedicle meets the burr. "Seal" is the base of a cast antler which plugs the dead antler from the core of the living pedicle. Above it, there is not yet ramified main stem of the antler called "shaft". The shaft continues into a "beam" which has potential to develop two types of branches: "sprouts" (pseudotines) or "tines" (points) (Cornwall 1964; Bačkalov 1979; A. B. Bubenik 1990, Fig. 3). Anatomy of antler becomes more complex with the age of the animal (Christensen 2004: 18). While an antler is growing, it is covered with highly vascular skin called "velvet" which supplies oxygen and nutrients to the growing bone. Growth occurs at the tip and is initially cartilage but later, after antler achieves its full size, it's replaced by bone tissue. At the end of the mineralization process, velvet is lost as the antler core dies. This dead bone structure is a mature antler that soon after falls off (A. B. Bubenik 1990). Antlers have outer compact tissue called the cortex and a spongy core which varies in thickness depending on many factors: part of antler in question, age and species of animal, size of an antler, etc. (O'Connor 1987; Vitezović 2010: 30). Despite having similar microstructure and chemical composition to bones, antlers are considerably different in structure; they are less mineralized than bones and have a higher proportion of collagen. There is also a difference between them in mechanical performance. Therefore, the antler is preferred for its elasticity and toughness for producing objects that will be subjected to particular stress (O'Connor 1987: 4; MacGregor 1991: 29-30; Christensen 2004: 20-21) while more brittle bones are better for making objects requiring sharp points and hard edges (Choyke 2013: 4).

Technology of processing osseous material

Antler objects can have a complex chain of operations because they can require multiple steps of reduction before an object can be shaped. Different techniques could have been used for prepping antler, such as soaking it in water or different solutions before it was sectioned into usable elements (Osipowicz 2007; Nicodemus and Lemke 2016: 113). There are up to four levels of manufacture involved in bone toolmaking: raw material selection, selection of the section of the bone that will be utilised, how was material treated to make it more suitable for rendering and how was it finally shaped. As mentioned, the first step in the chain of operations is raw material selection. That choice is conditioned by availability and physical suitability as much as it is conditioned by culturally ascribed tradition (Choyke 1984; 2013: 1-3). Both shed antlers and those from killed animals can be used as raw material (Choyke 1984: 27; Vitezović 2014: 154). The antler is consciously selected, searched for and gathered material. Individual stags tend to drop their antlers after the breeding period is over, which can be found at the same locations which makes it easy to gather them (Choyke 2010, 23; 2013, 3).

An important part of osseous material research is studying of traces left on the artefacts by manufacture techniques and by use. Traces of various techniques are usually well preserved but traces of wear are much more problematic. They are made last and are first to perish in the unfavourable and inadequate conditions. One tool can be used for more than one action, which makes a determination of its function more difficult. The bases of the traseological analysis are experimental reconstructions and analysis of traces under different magnifications (Vitezović 2010).

Process of transforming raw osseous material into objects can be divided into two basic steps: dividing the raw material into series of usable segments and shaping blanks into the desired object (Sztancs et al. 2010: 40; Vitezović 2010: 49).

1. The first step (*débitage*) is the intentional action of splitting a block of raw material into blanks for the purposes of further processing (Provenzano 2004a: 29; Vitezović 2016: 49).

2. Shaping (*façonnage*) refers to the intentional action of shaping a blank, regardless of the processing method that includes making a general layout of an object and adding specific attributes such as perforations, barbs, etc. (Provenzano 2004a: 29-30; Vitezović 2010: 49).

3. The third step is finishing work (*finition*) and elements added in this step no longer modify the general shape of an object. It includes, among other things, polishing and decorating activities that are not essential for the object to be functional and is done for an aesthetic reason (Provenzano 2004a: 29-30; Vitezović 2010: 49-50).

4. There could also be a fourth step that would account for repairing used or damaged object (Provenzano 2004a: 30; Sztancs et al. 2010: 40).

Chosen techniques, much like the choice of raw material, is culturally ascribed and greatly depends on tradition (Choyke 2013: 1). Dividing antler material into smaller segments (*débitage*) can be done using different techniques that were implemented in two principal ways: by breaking or by wearing away the raw material. Breaking can be implemented by two actions: fracturing and notching. Fracturing would mean violently breaking an element, which can be achieved by direct percussion with or without a hammer or indirect percussion. Notching is a form of percussion which can be implemented in three ways: by launched percussion or by indirect percussion with or without the hammer. Grooving is implemented by a repeated unidirectional movement that is parallel with the longitudinal axis of bone or antler and can be done by sharp flint or bronze point (Provenzano 2001; Vitezović 2016). On the other hand, sawing is a back and forth motion which is perpendicular to the longitudinal axis of the object and can be carried out with lithic edge or a metal blade (Provenzano 2001: 97; 2004a: 32). These techniques can be successful when applied to the thinner antler beams or tines that were usually separated first (Rigaud 2004: 79; Vitezović 2014:

157-58). Scraping consists of using a cutting edge on the surface of the material to reduce, regularise or sharpen objects. Edge is held vertically and scraping takes place in one direction along the longitudinal axis. Abrasion and polishing belong to the same set of technical gestures where the surface is worn by friction using a revolving or back and forth movement. Those terms are often not clearly defined and are variously employed through literature. Difference between them can be distinguished by determining the purpose for which they are used, by their place in the operational chain. Abrasion is a technique which removes a larger quantity of raw material and is employed either in débitage or more commonly in shaping. However, polishing is a technique which removes a small amount of material and usually takes place during the completion phase (Provenzano 2001).

Because of their properties, antlers usually had to be separated with a combination of techniques. There are two basic modes of exploiting antler: "débitage by segmentation", also known as "cut and break technique" and "débitage by extraction" also known as "groove and splinter technique" (Averbouh and Pétillon 2011: 41, Fig. 1). Most commonly used method is cut and break technique which means thinning of the outer layer and then separating, breaking off the remaining tissue (Rigaud 2004: 79; Vitezović 2016: 67, Slika VII/6, VII/7). Thinning of the outer layer can be done by various techniques; the goal is to remove enough of the outer layer until spongy tissue is reached. This can be done by cutting in a slit using stone or metal tool, by using abrasive agent and rope or by adzing or whittling – removing small portions of the material. The remaining tissue is then broken off by flexion or split using an axe or some other tool (Vitezović 2016: 67). Another method is groove and splinter technique that involves extracting longitudinal pieces from the external part of the antler via grooving procedure (Averbouh and Pétillon 2011: 41, Fig. 1:2; Vitezović 2016: 68, Slika VII/10).

Stone and metal tools leave characteristic imprints on osseous material, which can often remain recognizable even after the bone surface is damaged (Greenfield 1999). Metal knives produce sharp V-shaped or hard cornered |_|-shaped cuts (Fig. 2 a, b) and they either leave no striations or leave striations that are more uniformed depth and spacing than when done by stone tools. Generally, metal knives produce a cleaner and even cut with sharp parallel edges, with an exception of serrated-edge blades (saw-like) that leave very distinctive marks (Fig. 2 c) (Greenfield 1999; 2005; Christidou 2008). Stone tools produce a shallower, less even cut mark that in cross-

CODE	CUT MARK	DESCRIPTION
A		Profile of metal blade - sharp flat edge
B		Profile of metal blade - dulled flat edge
C		Serrated edge (saw - like)
D		Profile of a chipped stone scraper
E		Profile of a chipped stone blade - unrethouched
F		Profile of a chipped stone blade - unifacial rethouch
G		Profile of a chipped stone blade - bifacial rethouch

FIGURE 2. Templates for distinguishing metal and stone tool cut marks (after: Greenfield 1999: Fig. 1)

section has two distinctly different sides: a smooth and a rough side. The smooth side rises steeply and smoothly, the rough side rises more gradually with multiple striations left over from production (Fig. 2 d, e). Retouched tools may leave lateral striations on both sides of the apex, depending on whether they are unifacially or bifacially retouched (Fig. 2 f, g) (Greenfield 1999: 804).

Preliminary data from Kukuruzište Streim (2012-2015)

Most of the studied material in this paper comes from unpublished findings from Vučedol – Kukuruzište Streim, combined and compared with limitedly available material from Vučedol – Vinograd Streim. Because of the unfortunate circumstances, a lot of osseous material excavated at Vinograd Streim before the war (excavations campaigns 1984-1991) has been lost. Part of surviving material included in this research is a box of mostly osse-

	BONE	ANTLER	HORN	TEETH/TUSK	MOLLUSC SHELL	TOTAL
V-12	2	12	0	0	0	14
V-13	10	25	2	9	1	47
V-14	27	28	2	2	2	61
V-15	69	27	10	3	0	109
V-16	112	22	0	1	2	137
V-17	82	48	0	2	1	133
TOTAL	302	162	14	17	6	501

TABLE 1. Total number of artefacts made out of different raw material present at Kukuruzište Streim (2012- 2017)

ous finds belonging to the 1984 excavations.[1] That material was deposited at Department of Archaeology, Faculty of Humanities and Social Sciences in Zagreb. Thirteen of the finds are osseous artefacts (3 bone and 10 antlers) that originate from the pit named Pit 8 in field documentation. Those osseous finds consist of 2 rib spatulas and bone fragment with traces of manufacture and use. Antler artefacts include a perforated hammer and perforated axe made of antler bases, an axe or adze made from antler beam with only partly preserved perforation, a harpoon, four antler tines with traces of manufacture and use, an antler tine that had been segmented using cut and break technique and a shed antler whose beam and tine were cut off.

Osseous remains found at Kukuruzište Streim during excavations campaigns 2012-2017, include 1403 samples of animal remains, 247 samples of mollusc shells, 49 samples of fish bones and scales and two fragments of *Testudo* (turtle) plastron. This material is yet to be analysed. Furthermore, during the same excavation campaigns, 501 artefacts were found that are complete antlers or horns, finished tools, half-products and objects with traces of manufacture or use (Table 1). So far, this

	UNSHED ANTLER	SHED ANTLER	UNDETERMINED	TOTAL
V-12	1	0	11	12
V-13	0	2	23	25
V-14	2	3	23	28
V-15	0	4	23	27
TOTAL	3	9	80	92

TABLE 2. Total number of shed and unshed antler present at Kukuruzište Streim (2012- 2015)

[1] We express gratitude to the head researcher, prof. dr. sc. Aleksandar Durman, who provided us with this material and complete documentation from the Vinograd Streim excavation. Material in question was part of an exhibition that was held in Zagreb in 1988 (Durman 1988).

FIGURE 3. a) Shed antler with preserved base (Kukuruzište Streim) b) Roe deer antler still attached to the skull of the animal (Kukuruzište Streim). (Vučedol Culture Museum photo archive)

FIGURE 4. Complete antler that had its base and tip of the tines deliberately removed found in a pit (Kukuruzište Streim). (Vučedol Culture Museum photo archive)

data suggests that during manufacturing process bone as a raw material was used in 60 % of cases, antler and horn were used in 35 % of cases while remaining 5 % can be attributed to mollusc shells, tusks and teeth. Completely analysed were 231 osseous artefacts from 2012-2015 excavation campaigns including 108 osseous, 92 antlers, 14 horn, 14 tusk/teeth and 3 mollusc shell artefacts (Table 1).

At Vinograd Streim, red deer antler was preferred over roe deer antler, probably because of its size (Jurišić 1988b: 25-26; Kučera 1999: 11; Vitezović 2018: 180). The same can be assumed for Kukuruzište Streim, but the zooarchaeological analysis is required. Although uncertain, there is a possibility of fallow deer (*Dama dama*) antler tool originating from Vinkovci - Tržnica (Dimitrijević 1956: 412, T. XVII, 2). The number of shed antler with preserved bases (Table 2, Fig. 3 a) at Kukuruzište Streim suggests that gathering antlers was an important task that required people well familiar with the surrounding environment of the settlement (Choyke 2010: 23). Shed antlers are more solid and therefore more suitable for processing then the ones gained through hunting (Choyke 1984: 34; Toškan 2009: 300). However, examples from the same site that are still attached to the skull of the animal (Table 2, Fig. 3 b) indicate hunting. So far, data from Kukuruzište Streim indicate that 3 % of antlers are unshed while 10 % are shed antler bases and remaining 87 % are parts of antler beams and tines which, therefore can't be determined as a shed or unshed (Table 2). Although gathering antler seems to be a primary method of obtaining it as raw material, it is important to note that deer hunting was significant to the Vučedol community. For them, the motivation behind hunting seems to be more than simply obtaining raw material because it possibly had a religious and or social component to it (Milićević Bradač 2002). Importance of deer

	FINISHED OBJECTS	BLANK / PREFORM	BLOCK / RAW MATERIAL	WASTE	UNDETERMINED TECHNICAL PIECES	TOTAL
V-12	6	1	3	1	1	12
V-13	7	2	5	3	8	25
V-14	10	2	2	2	12	28
V-15	7	1	6	4	9	27
TOTAL	30	6	16	10	30	92

TABLE 3. Total number of artefacts representing different manufacturing stages of antler from Kukuruzište Streim (2012- 2015)

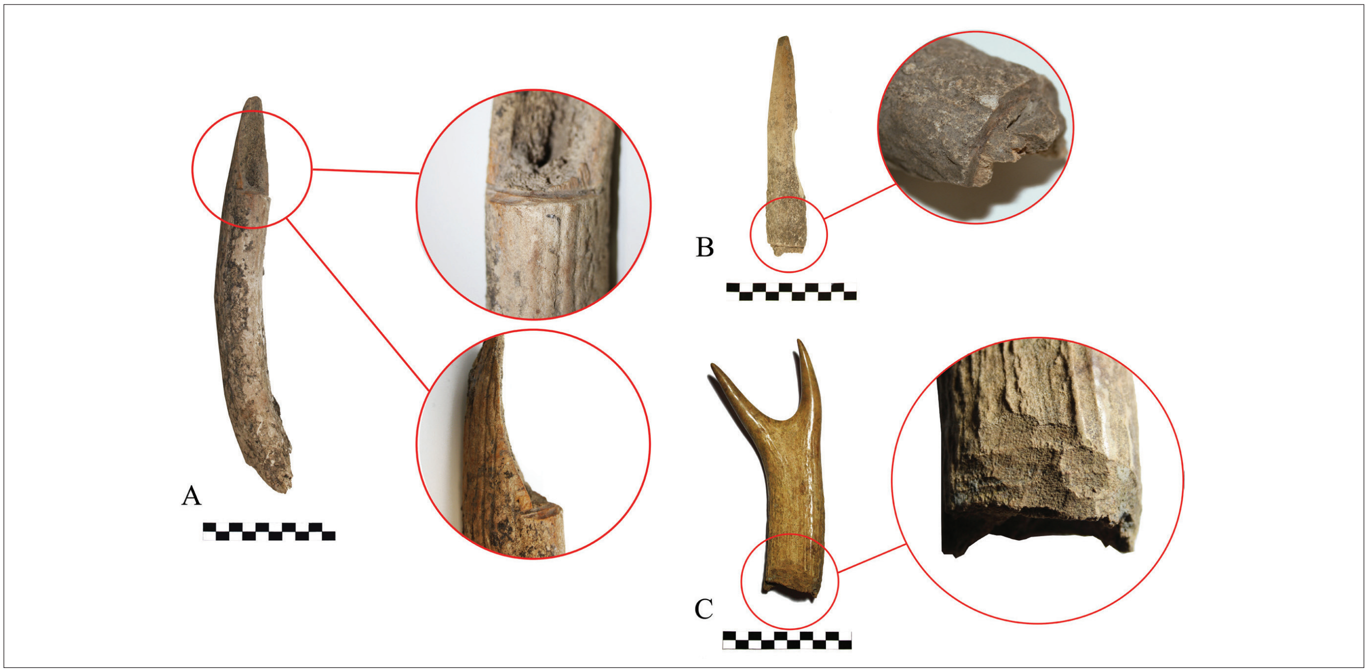

FIGURE 5. a) Example of transversal sawing, unfinished cut and break technique (Vinograd Streim) b) Example of cut and break technique (Kukuruzište Streim) c) Example of thinning the cortex by cutting off small portions of material (Kukuruzište Streim). (Vučedol Culture Museum photo archive)

and deer hunting is emphasized by the ritual burial of a deer on Vučedol – Gradac (Schmidt 1945: 28, T.16: 3; Milićević Bradač 2002: 9, Fig.1). Some authors suggest that during the Copper Age, deer hunting was also motivated by the need for the raw material not only meat and fat (Choyke 1984: 34-35; Toškan 2009: 300).

Examples of all antler manufacturing stages are recorded at the location of Kukuruzište Streim stored raw material, worked and abandoned pieces, waste, half-products and finished products (Table 3). After being collected, antlers can be stored for later use. They can be stored in cool and damp places for future use (Choyke 2010: 23; 2013: 3). During excavations of Kukuruzište Streim complete antlers and horn cores have been found in pits (Fig. 4). Ethnoarchaeological research shows that large waste fills were usually positioned at the edges of the settlement, while small household waste was disposed in the proximity of the house, in the pits that are considered part of household (Hayden and Cannon 1983). Pits could

	BREAKING (FRACTURING/ NOTCHING)	SAWING	CUT AND BREAK TECHNIQUE	UNDETERMINED	TOTAL
V-12	1	1	6	4	12
V-13	1	2	7	15	25
V-14	1	1	5	21	28
V-15	2	0	6	19	27
TOTAL	5	4	24	59	92

TABLE 4. Techniques of antler débitage from Kukuruzište Streim (2012-2015)

have had many different, even multiple functions but, in the end, most of them were filled with waste (Schiffer 1983: 691-92; Durman 1988: 16; Wilson 1994). Pits with more uniform content indicate activities and crafts that took place at the settlement (Hayden and Cannon 1983). Complete antlers found in pits at Kukuruzište Streim had their bases and sometimes tines deliberately removed. Some have traces of initial cuts that show antler was worked on and then abandoned for some reason. Pieces of un-worked or segmented antlers that are found in pits are likely to represent forgotten, stored antlers (Choyke 2010: 23; 2013: 3). We should also note that there is an instance of the whole antler found on the floor of the house, possibly abandoned during a fire which had left it burned and badly preserved (cf. Hayden and Cannon 1983: 159-60).

The methods used at Kukuruzište Streim and Vinograd Streim involve three basic techniques: sawing, notching and fracturing. Cut and break technique is most commonly used (Table 4): after sawing in a deep cut (Fig. 5 a), the object was rotated to make another cut, process which was repeated multiple times until outer cortex was removed and the spongy core was reached. The rest was then chopped off or, more commonly, broken by flexion (Fig. 5 b). Thinning of cortex by cutting off small portions of the material, presumably by using indirect percussion via chisel or another similar tool is also a commonly used technique (Fig. 5 c). Chop marks caused by direct percussion can be observed on some of the artefacts. Most of manufacturing techniques and methods were observed on abandoned pieces, waste and half-products, while finished objects have neatly abraded or polished ends which make determining such techniques more difficult.

Interestingly, specific manufacturing marks were noticed on the osseous material from Kukuruzište Streim, that hadn't been observed on limited material from Vinograd Streim. Striations marks are even in their width and spacing, cut marks have sharp parallel edges, they are uniform in width and depth and tend to get shallower towards the ends (Fig. 6 a, b), and therefore they indicate that metal tool was used in the exploitation of antler. Applied methods and techniques appear to be the same as previously noted, but the tool used in segmenting process is different. Interesting finds from the site are horn cores that have traces of human activates, they aren't cut all the way, but rather have incision marks. Incision marks are very even and uniform in their depth and width, and get shallower at the ends, what implies that they were done by metal tools (Fig. 7) (cf. example from Iron Age in Baron et al. 2016: 31, Plate 5).

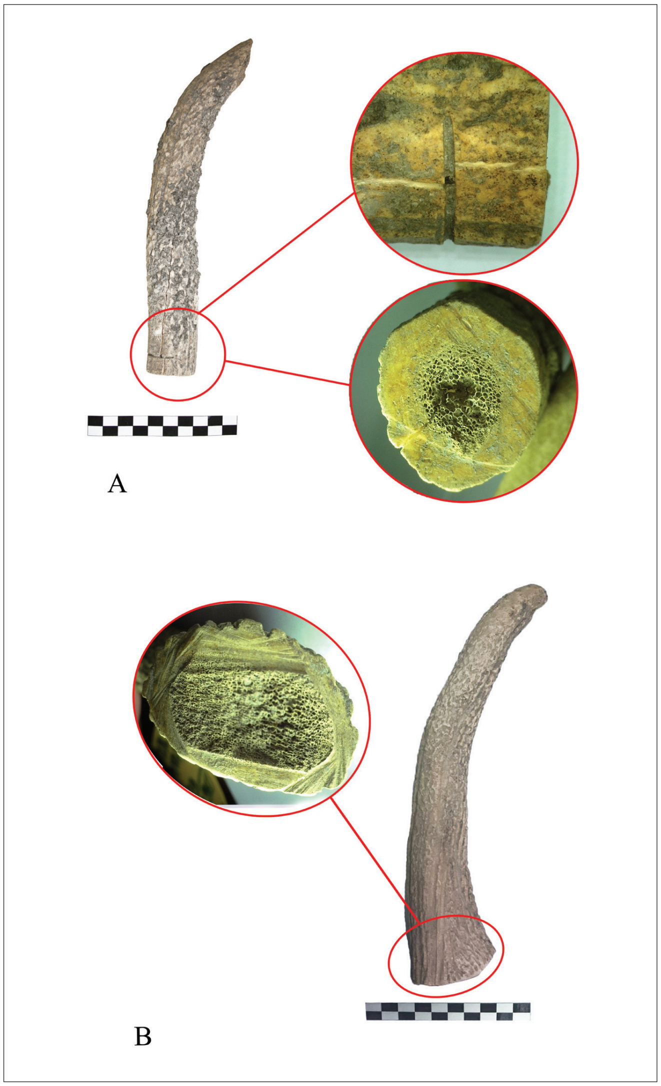

FIGURE 6. a) Example of an antler sawed with metal tool and traces of incision (Kukuruzište Streim) b) Example of cut and break technique implemented by sawing in a cut using metal tool (Kukuruzište Streim). (Vučedol Culture Museum photo archive)

Problem of using metal tools in the Late Copper Age

The idea that metal production resulted in the abandonment of other raw materials (flint, bone, deer antler) is now widely rejected (Choyke 1987; Provenzano 2001: 99). Nevertheless, not enough attention is provided to metal tools used in the manufacturing of osseous tools. One of the first researches to acknowledge using metal tools in bone working was Sergei A. Semenov, whose work was ground-breaking by using experiments and microscopic research in studying the stone and osseous remains (Semenov 1976: 165-67). Nowadays there is a growing interest in researches that deal with this problem, mostly using archaeological experiments (Olsen

FIGURE 7. Incision marks on the base of the horn that was made with metal tool (Kukuruzište Streim). (Vučedol Culture Museum photo archive)

1988; Greenfield 1999; 2005; Provenzano 2004b; Cristiani and Alhaique 2005; Christidou 2008; Jones 2011).

Studding usage of metal tools is very important in transitional contexts such as the Copper Age and adds to the existing debate. Metal tools are rare finds during Neolithic, Copper and Early Bronze Age but do not reflect the full range of artefacts available (Olsen 1988: 337; Greenfield 1999: 797). One explanation is that it reflects the actual prehistoric rarity of metal tools. Another possibility is that it was such a precious commodity that it was frequently recycled. The third possible reason for the rarity of archaeological metal finds is that early metals were chemically unstable and decomposed relatively rapidly under most conditions (Greenfield 1999; Christidou 2008: 734). A study conducted by H. J. Greenfield, on two sites in central Serbia (Petnica and Ljuljaci) with sequences that range from Neolithic to the Bronze Age, states that metal cut marks appear already during the late Neolithic - Vinča culture despite their inefficiency, and percentage of metal cut marks gradually increase with time (cf. Greenfield 1999: 804-808).

A. Durman was the first one to connect precise markings visible on Vučedol – Vinograd Streim osseous material with a metal tool. His conclusion was prompted by the bronze saw found on Vinograd Streim. Saw which has traces of tin (2.2%) and arsen (1.1 %) in its composition (Durman 2006: 60-61) does not belong to Late Copper Age Vučedol culture, but rather to the Early Bronze Age period. It was first published by S. Forenbaher (1990) who dates it in the middle and late Bronze Age – Belegiš culture and it was later mentioned by A. Durman (2006) who ascribed it to the Early Bronze Age Somagyvar – Vinkovci culture. Recently, traces of metal tools in antler manufacture were noticed on osseous material from Vučedol culture sites Sarvaš and Zók (Mitrović and Vitezović 2017: 187-88; Vitezović 2018: 180).

Difference between the sites and periods in adopting the usage of metal tools collaborate conclusion made by Rozalia Christidou (2008: 733-734):*" The frequency, type, raw material, and technique of manufacture of the bone objects made using metal tools vary between sites and chronological phases, suggesting different patterns of adoption of the functional metallurgy, possibly related to the availability of metallic substances and local social and economic factors".* Considering all this, it is not surprising that Vučedol site, as one of the metallurgical centres of the region (Schmidt 1945; Durman 1983; 1997; 2006), quickly implemented usage of metal tools in their manufacturing process. That change would be especially visible in working antler, as it was proven to be a more demanding material to process then bones, as those two materials are most commonly used at Kukuruzište Streim.

Conclusion

The great number of artefacts and tools testify that the technology of processing hard animal material was an important part of Vučedol Culture. This paper's focus is on the antler and its role in the osseous industry of Vučedol site. Antler was very desirable material, not only in Vučedol culture but throughout Copper Age of South-Eastern Europe with a distinctive preference for red deer over roe deer (Choyke 1984: 34-35; Toškan 2009: 300). Its properties, elasticity and toughness make it suitable for making a wide range of durable tools and objects. Antler was purposely targeted raw material source that came not only from hunting but from the organized and systematic gathering which requires a great amount of social organization and specialization. At the location of Kukuruzište Streim examples of a whole, probably stored antlers worked and abandoned pieces, waste, half-products and finished products can be found. The raw material was acquired, brought to the settlement where it was worked on until the finished product was made, after which it was used until it was discarded or lost. Various implemented techniques and different stages of osseous tool manufacturing process that are recorded at Kukuruzište Streim, all point to the existence of workshops inside the settlement, as was already suggested and presumed for other Vučedol Culture settlements such as Sarvaš and Zók (Mitrović and Vitezović 2017: 187-88; Vitezović 2018: 182). Methods and techniques used in antler tools manufacture are unified and vary a little. Sawing, notching and fracturing were basic three used techniques, that were commonly combined in cut and break and groove and splinter techniques. The antler is a very difficult material to work with and combination of techniques is necessary to divide it. Therefore, Vučedol communities during manufacturing process introduced metal tools, while continuing to use previously well-established methods and techniques of antler working. It shouldn't be surprising that Vučedol culture, that had developed local production of metal[2], tried very early on, to incorporate metal tools in their everyday tasks.

Although Vučedol osseous material shows very possible indications of common and frequent usage of metal tools in everyday life, much more extensive study is required. That study could account for, not only the problem of earliest metallurgy and technology but the problem of Vučedol culture chronology, dating and its role in the transition to Early Bronze Age. Manufacturing traces on osseous material can greatly add to the understanding of early metallurgy and the role it played in everyday life of Copper Age people. South-eastern Europe is one of the regions that experienced autonomous development of metallurgy and will prove to be very important in understanding the role of metal in the transition period of late Copper Age to early Bronze Age.

[2] Five furnaces excavated at Gradac offer a positive proof of Vučedol site being an existing metallurgical centre. Furthermore, the discovery of several objects such as a bronze axe with corresponding mould, an ingot, a few other bronze artefacts and pieces of slag, support the above mentioned theory (Schmidt 1938; Dimitrijević 1979, T. XLIII:4, Durman 1983; 2006).
During recent excavations of Kukuruzište Streim three furnaces which differ in their structure were found, as well as a dozen bronze tools. Tools are mostly small and precisely made. Therefore, they could point to very skilled metallurgist. Some of those bronze tools share context with at least one furnace, and together with pieces of slag strongly indicate an existence of metallurgical workshop at Kukuruzište Streim (information available in unpublished excavation reports by D. Roksandić, A. Durman and M. Hutinec from 2015, 2017, 2018 and 2019).

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