O P V S C V L A

A R C H Æ O L O G I C A

UDK 902-904 ISSN 0473-0992

IZDAVAČ / PUBLISHER
ARHEOLOŠKI ZAVOD FILOZOFSKOG FAKULTETA SVEUČILIŠTA U ZAGREBU
DEPARTMENT OF ARCHAEOLOGY, FACULTY OF HUMANITIES AND SOCIAL SCIENCES, UNIVERSITY OF ZAGREB

ADRESA IZDAVAČA / ADDRESS OF THE PUBLISHER
Arheološki zavod Filozofskog fakulteta
Department of Archaeology, Faculty of Humanities and Social Sciences
10000 ZAGREB – CROATIA
I. LUČIĆA 3 – P.O. BOX 171

RAČUNALNI PRIJELOM / COMPUTER LAYOUT
Ivanka COKOL for FF-press

PRIJEVOD NA ENGLESKI / TRANSLATION TO ENGLISH
Ana ĐUKIĆ & Vinita RAMLJAK

GODIŠNJAK / ANNUAL

Izdavanje časopisa novčano podupire
ODSJEK ZA ARHEOLOGIJU FILOZOFSKOGA FAKULTETA SVEUČILIŠTA U ZAGREBU
Publishing of the journal financially supported by
DEPARTMENT OF ARCHAEOLOGY, FACULTY OF HUMANITIES AND SOCIAL SCIENCES UNIVERSITY OF ZAGREB

Službena kratica ovoga časopisa je *Opusc.archaeol. (Zagreb)* / Official abbreviation of this journal's title is *Opusc.archaeol. (Zagreb)*
URL: www.ffzg.hr/arheo/opuscula

Dostupno na / Available at Ebsco Publishing (www.ebscohost.com)

Tiskano 2018. / Printed in 2018

OPVSC. ARCHÆOL. VOL. 39/40 STR. / PAGES 1–297 ZAGREB 2018.

OPVSCVLA ARCHÆOLOGICA

2018

OPVSC. ARCHÆOL. VOL. 39/40 STR. / PAGES 1–297 ZAGREB 2018.

FILOZOFSKI FAKULTET
SVEUČILIŠTA U ZAGREBU
FACULTY OF HUMANITIES
AND SOCIAL SCIENCES,
UNIVERSITY OF ZAGREB

RADOVI ARHEOLOŠKOG ZAVODA
PAPERS OF THE DEPARTMENT
OF ARCHAEOLOGY

UDK 902-904 ISSN 0473-0992

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Selena Vitezović

MANAGING RAW MATERIALS IN PREHISTORY: THE IMPORTANCE OF STUDYING OSSEOUS RAW MATERIALS

doi: 10.17234/OA.39.1
Pregledni članak / Review paper

UDK / UDC 338.3:62-9:903-035.56
Primljeno/Received: 14.10.2015.
Prihvaćeno/Accepted: 12.04.2016.

Selena Vitezović
Institute of Archaeology
Kneza Mihaila 35/IV
Belgrade, Serbia
s.vitezovic@ai.ac.rs
selenavitezovic@gmail.com

The analysis of raw material acquiring and managing is the first, and one of the most important steps in the technological analysis. For prehistoric communities, particularly important were the raw materials of animal origin, which were used in almost all the cultures and all the periods for producing diverse everyday tools and decorative items. They were in most cases readily available and in large quantities, and also relatively easily transformed into usable everyday items. Although often regarded as ad hoc used kitchen debris, the choice of raw materials was in many prehistoric communities very careful and strict, directed by physical and mechanical properties of different raw materials, as well as by cultural preferences. Study of methods of acquisition and exploitation is important for studies in economy, craft production, as well as social relations and relations of prehistoric communities with their environment.

Key words: prehistory, bone industry, osseous raw materials, raw material managing, technology

Introduction

The analysis of raw material acquiring and managing is the first, and one of the most important steps in the technological analysis. Technology (from Greek word τέχνη, meaning skill) is a conceptual approach to the material culture studies, that encompasses all the human actions upon a matter, from individual level (body gesture, embodied knowledge in crafting) to the social and cultural setting of production (cf. Inizan *et al.* 1999; also Miller 2007 and references therein). Technology or technological systems can be roughly described as processes and practices associated with production and consumption, from design to discard (Miller 2007: 5). The view of technology as a cultural-driven phenomenon implies that there is usually more than one technique that satisfies the minimum requirements for any given task; and that the choice of a particular technology among the alternatives may be strongly influenced by beliefs, social structure and tradition within the given society (cf. Lemonnier 1992; 1993; see also Killick 2004).

Raw material choices are, therefore, influenced by various factors such as availability (including avail-

able quantities and possibilities for extractions with available technology) and physical and mechanical characteristics, but also social, cultural preferences, traditions, etc. Important questions in analyses are also why a specific material was chosen and not some other – some raw material may be readily available or exist in the environment and yet remain unused.

Analyses of raw material may provide information on the exploitation of the environment; the relative distance of the sources from the settlement may point to the territory used or controlled by some group, routes of trade and exchange, or, in a case of hunter-gatherers, routes of migration and/or territory covered. Technology of extracting some raw materials, such as stones or ores, may indicate the level of technological knowledge and organization and the overall economic system within a community that explored them.

Analyses of raw materials are for long time an essential segment of research in lithic studies (e. g., Antonović 1997; 2003; Biró 1998; Gurova 2011; Šarić 2004, to mention just a few; see also Andrefsky 1994; 2005). Studies focused on osseous raw materials, however, were not so abundant until past few decades, when the interest in osseous raw materials increased (e. g., McGhee 1977; Guthrie 1983; Scheinsohn & Ferretti 1995; Allentuck 2013; Margaris 2014; see also Choyke & Schibler 2007; Choyke 2013, with references therein). Very often, bone industry was regarded as *ad hoc* use of kitchen waste, something that was easily made, easily discarded and less valued as, for example, painted pottery, retouched microblades or polished stone tools. Furthermore, even today a certain dichotomy still exists between "specialist" (in this case, zooarchaeological) and "archaeological" studies (focused mainly on typology and chronology). Bone artefacts (particularly beautiful pieces) were for long time, treated entirely separately from faunal remains, so the information on raw material selection is lost. Sometimes also happened that some of bone artefacts were treated completely as part of the faunal studies (especially manufacture debris either passed unnoticed or only gained the remark "other taphonomic traces"), leading to the loss of information on technology.

The potential of analysis of raw material selection is particularly enlarged when combined with zooarchaeological analysis (cf. Choyke 1984; 1998; 2013, see also Vitezović & Bulatović 2013); it may provide excellent insight into the technological choices regarding raw material exploitation, since the availability and mechanical properties of specific materials can be directly observed (not to mention the importance of zooarchaeological information that may be obtained from tool analyses). Furthermore, different animals often have ascribed symbolic value and meaning (either positive or negative), so the raw material preferences and avoidance may point to some of symbolic aspects in a given prehistoric community (cf. McGhee 1977; Pickenpaugh 1997; Choyke 2010b; 2013).

Osseous raw materials: physical, chemical, mechanical characteristics and availability

The term "bone" usually refers to all osseous raw materials or bone in wide sense, i.e., hard animal tissue *(matières dures animales),* and includes bones, antlers, teeth, mollusc shells, and also keratinous tissues and egg shells, used in some parts of the world (cf. Averbouh 2000: 187; Poplin 2004: 11).

All osseous raw materials have in common the trait of being composed of organic and inorganic matter. Separately, these are inferior support materials, but as organic composite they have traits which transcend their respective behaviours – the inorganic compounds bring rigidity and hardness, and organic material contribute to toughness, resiliency, and elasticity (Christensen 2004: 18–19; Reitz and Wing 2008: 39, see also MacGregor 1985: 1–22).

All these materials may be obtained locally, but also through short or long distance trade and exchange; they may be used immediately after acquiring or may be stored and used months later.

Physical, chemical, mechanical properties

Bones (fig. 1). Bones are the main support for the animal body, that provides areas for muscle attachment and protects vital organs, therefore they must be at the same time strong and elastic (Davis 1987; Reitz and Wing 2008). Chemically, they are composed of inorganic and organic matter – crystalline calcium phosphate salt and collagen, that forms long fibres, and other organic substances (cf. Davis 1987: 47).

Morphologically, bones may be grouped into long, flat, short and irregular bones (Davis 1987: 47 *ff.*; O'Connor 2000: 5 *ff.*). (For details on bone structure, vertebrate skeleton, etc., cf. Davis 1987; O'Connor 2000; Reitz & Wing 2008, and references therein).

Long bones (femora, tibiae, fibulae, humeri, radii, ulnae, metacarpal, metatarsal bones…) are hard, dense bones that provide strength, structure, and mobility. All long bones, and particularly femur and

tibia, are subjected to most of the load during daily activities and they are crucial for skeletal mobility. They consist of a cylindrical shaft (diaphysis), of dense, compact bone, that encloses marrow cavity, and of epiphyses, with spongy tissue, at both ends. Flat bones (cranial bones, ribs, scapulae…) are made up of a layer of spongy bone between two thin layers of compact bone. Their shape is flattened, not rounded, and, unlike long bones, they do not have a bone marrow cavity.

Bones represent a primary product, since animals must be killed, and were mainly obtained from those animals that were killed for food. Bones may be separated during primary butchering, or collected later from refuse at the end of consumption process (cf. Choyke 2010a).

Teeth. Teeth consist of a dentine core and an enamel crown, they are as hard as bone or substantially harder (Reitz & Wing 2000: 46). Same as bones, they were obtained from animals used in diet, although sometimes teeth that were specially valued may have been targeted for and intentionally searched for (taken from dead animals that were not killed for food, for example).

Ivory is a general term that usually refers to specialized teeth among walrus, hippopotamus and *Proboscidae* (elephants etc.); they are enormous in size and composed almost entirely from dentine. In walrus, the teeth in question are upper canines, while in elephant these are upper incisors (cf. MacGregor 1985: 14–19; Christensen 2004).

Antlers (fig. 1). Antlers are specific skeletal outgrowths, found among deer (*Cervidae*), present in almost every deer species. Except in reindeer (*Rangifer tarandus*), where females also have antlers, they are exclusively male characteristic (Davis 1987: 59; Reitz & Wing 2008: 62–63). Antlers have outer compact tissue (cortex) and spongy tissue in the interior; proportions of these two depend on the portion of antler (cortex is thicker on tines, and more spongy tissue is found on the beam), but also on the species, age of the individual, etc. (MacGregor 1985; Christensen 2004).

Their microstructure and chemical composition is similar to bones; although the mineral content is lower in antler than in bone, so bone is more rigid and antler is much more flexible. Mechanical properties of antlers differ in longitudinal, radial and tangential axis; they are more resistant longitudinally, along the fibres, but are more fragile perpendicularly (Guthrie 1983: 278; Christensen 2004: 18–19, see also Currey *et al.* 2009).

Antler is more resilient and will absorb much energy under impact before breaking, and it is this feature that makes antlers such an ideal material to be used as a hammer or a digging implement, however, it is not as dense as bone, and it is not, therefore, very convenient for a sharp edge. Stags use their antlers to defend harem by fighting off rivals; they strike at trees with antlers, prepare scrapes and wallows in the ground, etc. to frighten the rivals and to mark the territory. Antlers are also used as weapons, wrenched and twisted while locked into opponent's antlers, so they must be able to withstand some degree of plastic deformation without fracturing. The work of fracture (a comparison of bending ability) for antlers is four times that of a bone (Guthrie 1983: 278; MacGregor 1985: 26–28; Clutton-Brock 1984: 16–17).

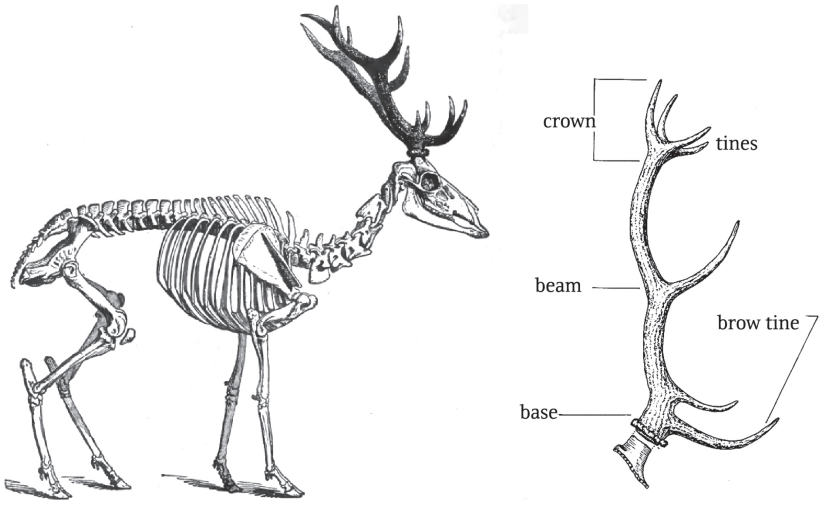

Figure 1. Animal skeleton and basic morphology of red deer antlers. (after MacGregor 1985)

Both shed antlers (*bois de chute*) and those from killed animals (*bois du massacre*) can be used as raw material, although the use of shed antlers is simpler – it is easy to collect them in late winter, as stags tend to drop them at same locations; this is also a renewable resource and they are of better quality as raw material than unshed antlers, because the process of mineralization is finished and all the soft tissue is already removed (cf. Schibler 2013: 346).

Keratinous hard tissues. Also keratinous hard tissues were used in diverse periods. They are almost never preserved in the archaeological record, although at least some of them must have been used in prehistoric times. Keratin has rigid fibrillar structure and is synthesised in the epidermis, and keratinous tissues include hooves, horns, feathers, claws, baleen. Horns are cranial outgrowths among cattle, ovicaprines, antelopes. They consist of non-deciduous cuticle composed of keratin and laid down in the form of a sheath surrounding a bony horn core (*os cornu*), projecting from the frontal bones at either side of the skull (MacGregor 1985: 19–20). Their use is well documented in ethnographic record and in post-medieval times (cf. Rijkelijkhuizen 2013), and for earlier periods sometimes indirect evidence may be available, such as horn cores with traces of cutting (e. g., Lisowski 2014).

Shells. Shells are the external skeleton among the phylum *Mollusca*, made of calcium carbonate. Molluscs may have been used in food or the shells were simply gathered on sea-shores, and were used in their natural shape, or modified into diverse objects. Three classes are important for prehistoric archaeology – *Gastropoda* (snails), *Bivalvia* (bivalves) and *Scaphopoda* (tusk shells) (cf. Reitz & Wing 2008). They were used as containers, money, games, but were most widely used as ornaments, in almost all corners of the world, since Palaeolithic times (Taborin 1993, 2004).

Managing osseous raw materials

The choice of specific skeletal element from a specific species is influenced by many factors – availability, physical and mechanical properties, and also cultural attitude towards certain animal. According to V. Scheinsohn (2010), the factors for raw material choices in osseous industries may be grouped into the *natural factors*, that include mechanical properties of bone available and environmental factors (faunal richness, raw material availability), and *cultural factors*, i. e., economic system and technological organization of the given community (Scheinsohn 2010: 12).

The choice of skeletal elements and taphonomic traces on bones can indicate how the bones were obtained and can also provide information on butchering techniques. Large use of metapodial bones, for example, indicates that they were selected for later use during primary butchering (cf. Olive 1987 for butchering techniques), suggesting planned use of bones as raw materials. Traces of rodent gnawing, etc., on the other hand, if clearly preceding manufacturing and usewear traces, may suggest bones were used in more *ad hoc* manner.

Physical characteristics of specific skeletal elements make them convenient for specific tool types. Long bones can be easily divided along their length and also are resistant to breaking, and therefore are convenient for diverse pointed artefacts. Small ungulate metapodials were preferred choice in numerous communities for pointed tools; particularly metapodials from sheep/goat were very common in Neolithic and Chalcolithic communities across Europe (e. g., Voruz 1984; Pascual Benito 1998; Hüser 2005; Beldiman 2007, Legrand 2007, Vitezović 2007, 2011) (fig. 2). Flat bones, for example, can be used as scrapers and burnishers, especially ribs (e. g., Beldiman 2007, Vitezović 2007, Mărgărit 2017), short bones were sometimes used in their natural shape or slightly modified (cf. Vitezović 2007, Mărgărit 2017) (fig. 3), and so on.

Figure 2. Ovicaprine metapodial bones used for tools (site of Vitkovo, Serbia, Vinča culture). (by: S. Vitezović)

Figure 3. Used astragals (site of Kovačke Njive, Serbia, Vinča culture). (by: S. Vitezović)

When it comes to teeth, only some may be used as tools, due to their physical properties, namely size and shape. Boar tusks, which are particularly strong and have elongated, curved form, were used for scrapers, knives, etc. (e. g., Beldiman 2007). Occasionally, mandible fragments with teeth inside may be encountered (e. g., Deschler-Erb *et al.* 2002).

Animal teeth from a variety of species were used as ornaments, amulet and/or symbols of identity and prestige in many prehistoric communities, since the Palaeolithic times (cf. Taborin 2004). They represented the whole animal and its ascribed characteristics, embodying the *pars pro toto* principle (Choyke 2010a: 24). There are examples of both herbivore and carnivore teeth used, and both wild and domestic animals (e. g., Pascual Benito 1998: 133–135, Deschler-Erb *et al.* 2002: abb. 521, 522), and particularly interesting example is the use of red deer canines. Residual canines of red deer have a characteristic, unusual drop-like shape and were used for pendants since the Palaeolithic times. In later prehistoric periods, there are numerous cases of them being replaced by another material – bone or even stone (cf. Choyke 2002, with references therein), presumably, because it was difficult to acquire a desired quantity.

Also ivory was used since the Palaeolithic for diverse, mainly non-utilitarian items; some of the most beautiful Palaeolithic figurines were made in mammoth ivory (Schibler 2007: abb. 1, 2). Ivory was particularly valued because of their colour, resistance, and also origin, particularly exotic origin in later prehistoric and also historic periods (Choyke 2010a: 24–5; see also Banerjee & Eckmann eds. 2011).

Antlers, as particularly resilient and resistant to shock, were often used for punching and other heavy duty tools (fig. 4, 5). In the Neolithic communities in present-day Switzerland, they were often used as sleeves for stone axes and adzes, as shock absorbers (Schibler 2001, 2007, 2013, and references therein).

Antlers differ from other skeletal elements as they may be gathered, i. e., the animal need not to be killed and it is even easier to use shed antlers (see above). The use of antlers, therefore, may reveal interesting relations between prehistoric communities and their environment.

Figure 4. Unshed red deer antler modified into hammer-axe (site of Divostin, Serbia, Vinča culture). (by: S. Vitezović)

For example, J. Schibler noted, among Neolithic settlements in Switzerland, direct link between hunting deer and use of antlers – the ratio of antlers decreased when animals were hunted in large

Figure 5. Red deer antler tine used as retouching tool (site of Starčevo, Serbia, Starčevo culture). (by: S. Vitezović)

numbers, and vice versa, when hunt was less active, more antlers were in use as raw materials (Schibler 2001).

Choice of species may be purely functional – large mammal bones are thick and large enough for producing heavy duty tools, while small mammal bones can be easily transformed into finely-shaped needles, etc. Also, such choice may give information on subsistence and economy, butchering techniques (for example, were the hunted animals butchered at the killing place or within the settlement) and may also be influenced by cultural preferences (preference or avoiding skeletal elements from specific animals) (e. g., Sidéra 2000). The question of wild vs. domestic fauna may be interesting, particularly in the case of the early agricultural communities and this was the focus of study by G. le Dosseur in Natufien and early Neolithic communities in the Levant (le Dosseur 2007).

In the case of ornamental items, that were often also amulets, symbols of identity and/or prestige, the choice of raw material was particularly important, but the choice species for everyday tools may as well reveal information on relations between humans and their environment. The analysis of modified metapodial bones from Early Bronze Age from sites in Israel by A. Allentuck (2011) suggested that social meanings attributed to specific animals and specific skeletal elements structured procurement decisions.

One of the classical studies on symbolic value of raw materials is the one on the osseous raw materials, by R. McGhee (1977), on raw material choices within the Thule culture in arctic Canada. McGhee clearly demonstrated that the use of antler, ivory and bone for specific artefacts is by no means accidental, and is in fact strictly linked to the worldview. From the relations between the raw material and their products, McGhee reconstructed oppositions land/sea, summer/winter, man/women, antler/ivory.

Mollusc shells are usually considered as prestigious raw materials, especially in continental Europe, where these were obtained via long distance trade. In the Neolithic and Chalcolithic Europe, *Spondylus* shell jewellery was especially "fashionable" – bracelets (fig. 6), beads, pendants and other decorative pieces were discovered at numerous sites, usually with traces of long use, sometimes even repair, sometimes placed in graves, or discovered within ritual contexts (cf. Borrello & Micheli 2004; Séfériadès 2010; Siklósi & Csengeri 2011; with references therein). It was assumed they represented a prestigious items, although their meaning and value must have varied in different periods and regions (cf. Séfériadès 2010; Siklósi & Csengeri 2011).

Some aspects of exploitation of osseous raw materials in the prehistory of the South-East Europe

In the Starčevo culture, bones from domestic animals seem to be the predominant raw material (Vitezović 2011). Although hunting still has importance in economy at some sites, bones obtained from sheep, goat and cattle were most commonly used. Antlers were also widely used (fig. 5), mainly from red deer and to a smaller extent from roe deer;

obtained mainly through collecting, most probably in the vicinity of settlements. They were used in a planned, systematic way but their presence at different sites varies considerably; they are particularly abundant in the Iron Gates region, presumably due to the environment (Vitezović 2011, 2014).

Cattle bones, and in particular *Bos* metapodials were preferred, even exclusive choice for a specific techno-type – spatula-spoons with an elongated handle and finely shaped spoon-segment, oval, leaf-like or elongated (fig. 7). They were widespread not only in Starčevo culture, but also in other Early Neolithic cultures in the Anatolia and South-East Europe (cf. Nandris 1972; Beldiman 2007; Vitezović 2011). These artefacts were carefully made, in use for a very long time and it was suggested that the choice of species is connected with the value given to them (such a choice contributed to their value and/or the such a choice was made because these were prestigious items). Apart from this, we may observe that *Bos* bones were also often used for some decorative items, such as buckles, discs, etc. (Vitezović 2012).

Interesting is also the use of skeletal elements from red deer – antlers were not just used for tools, but for jewellery as well (bracelets, pendants) and also red deer canines, popular and valued in other prehistoric cultures, were important within Starčevo culture as well (cf. Vitezović 2012). Both *Bos* and deer had symbolic value within Starčevo culture (Vitezović 2015), and the use of their skeletal elements was certainly connected with symbolic meaning ascribed to them.

In the Late Neolithic/ Early Chalcolithic Vinča culture, osseous raw materials were obtained mainly from domestic animals used for food, only rarely from hunted animals, through selective collecting and through exchange (Vitezović 2013; Vitezović & Bulatović 2013). Careful selection was practised both among species and skeletal elements. Sheep and sheep-size animals, although not the most numerous in faunal record, were main source for bones (fig. 2). Cattle and large mammals follow, while pigs were mainly avoided. As to skeletal elements, metapodials were preferred, which suggests careful and planned removing during butchering process and probable storing. Some bones, such as cranial were generally avoided, but used teeth show completely different picture – teeth from wild species were used as decorative objects and pig teeth were the only one used for making tools. Antlers were also widely used, mainly shed, although occasionally unshed may occur as well (fig. 4).

Neolithic and Chalcolithic communities in Europe valued very much mollusc shells, particularly *Spondylus* (see above), although other species were also in use. *Spondylus* was used for diverse ornamental pieces – bracelets, beads, buckles, etc., sometimes with traces of re-use or repair. Mollusc shell finds are not numerous in Starčevo (cf. Vitezović 2011, 2012) (fig. 6) and Vinča culture, but often have traces of long use, even repair. At the Vinča culture cemetery of Botoš–Živanića Dolja (Marinković 2002, 2010), numerous finds of *Spondylus* and *Glycymeris* jewellery testify on their importance as symbols of value, prestige, identity and/or status.

Neolithic cultures in the South-East Europe are famous for their figurines, both zoomorphic and anthropomorphic, found in abundance at all the sites. They were made almost exclusively from clay, only rarely from stone and never from osseous materials. Osseous materials were used for tools and ornaments, but never for artistic expressions. On the other hand, in the Iron Gates Mesolithic from several sites originate pieces with incised decoration from bone, antler and stone (Bačkalov 1979). Figurines from bone appear in the Chalcolithic period, they are numerous in present-day Romania

Figure 6. ***Spondylus*** *bracelet and* ***Dentalium*** *bead (site of Starčevo, Serbia, Starčevo culture). (by: S. Vitezović)*

Figure 7. Spatula-spoon from Bos metapodial bone (site of Donja Branjevina, Serbia, Starčevo culture). (by: S. Vitezović)

and Bulgaria (cf. Averbouh & Zidarov 2014, with references therein; see also Vitezović & Bulatović 2015) and recently one fragmented figurine was discovered at eponymous site of Bubanj culture of the Bubanj–Salcuța–Krivodol cultural complex, Bubanj near Niš (Vitezović & Bulatović 2015). This means that over time cultural attitude towards raw materials changed significantly – at certain periods they were considered inadequate for figurines and other artistic expressions.

Discussion and conclusion

Although often regarded as *ad hoc* used kitchen debris, in many prehistoric communities the choice of raw materials was very careful and strict, directed by physical and mechanical properties of different raw materials, as well as by cultural preferences. Study of methods of acquisition and exploitation is important for studies in economy, craft production, as well as social relations and relations of prehistoric communities with their environment. Detailed analyses of raw material selection, combined with data obtained by zooarchaeological, environmental and other studies, may yield important data on butchering techniques and general exploitation of animals for food and other resources, exploitation of the environment, organization of diverse activities, such as hunting, gathering, different raw material exploitation, craft production, and many more. Also, some symbolic aspects of worldview related to animal world may be revealed (special meaning and importance of certain animal species).

In the Neolithic and Chalcolithic cultures of the South-East Europe, the skeletal elements and species were carefully chosen in a planned and systematic way, probably placed aside already during the primary butchering. Although some expediency in raw material selection may occur from time to time, bone industry in almost all prehistoric periods was in general planned and reveal a systematic use of specific skeletal elements for determined tool types. Such a choice of raw materials is consistent with their mechanical and physical properties and with the desired final product (sharp tip, heavy percussion tool). Some degree of cultural preference towards certain skeletal elements and species is beyond doubt (for example, preferred choice of wild species and exotic raw materials for decorative items), but, still more evidence is needed for a thorough analysis of the level of influence of cultural reasons on technological choices, as well their meaning and symbolic value.

Acknowledgments: This paper is the result of work on the projects "Archaeology of Serbia: cultural identity, integrational factors, technological processes and the role of the central Balkans in the development of the European prehistory", no. OI 177020, and "Bioarchaeology of ancient Europe: humans, animals and plants in the prehistory of Serbia", no. III 47001, funded by the Ministry for education and science.

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