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Manufacturing technique and social identity: three cases of 'manufacture-by-wear' technique

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ABSTRACT: This paper focuses on the identification of changes in the processing of osseous materials in the southeast European Neolithic, beginning with three types of production by manufacture wear technique typical for the region: bipartition by abrasion, segmentation with fibre and perforation by wear technique. The processing of osseous materials is strongly conditioned by their natural anatomic shapes which is why only a restricted range of possible transformation variables, with minimum changes through time, would be expected. However, numerous specialists invoke the cultural value conferred by the community as the preeminent element in the selection of raw material more than the limitations of the raw material form. Therefore, there are some examples in which there was little change in raw materials selection across long periods of time, although there was variation in animal species availability. Consequently, the study of the three types of 'manufacture-by-wear' technique becomes more interesting. These techniques are not present in all prehistoric times in this region. Some of these techniques appear on worked osseous materials in Romania and neighbouring areas at the beginning of the Neolithic and disappear just as suddenly (bipartition by abrasion) or appear only sporadically (perforation and segmentation with fibre) by the Early Chalcolithic. Based on experimental reconstructions of the three processing techniques and comparing them with archaeological assemblages, our study aims to register all the relevant variables (technological gestures, time required for each operation, tools used etc.), and evaluate if they represented a real innovation in the way which the osseous materials were processed.

KEYWORDS: SOUTHEASTERN EUROPE, ROMANIA, NEOLITHIC, OSSEOUS EXPLOITATION, TECHNOLOGICAL CHOICES, CULTURAL TRADITIONS

RESUMEN: Este trabajo se centra en la identificación de cambios operados en el procesado de materiales óseos en el Neolítico del sudeste europeo a partir de tres tipos de producción de manufacturas por la técnica de desgaste que son típicas de la región: bipartición por abrasión, segmentación con fibra y perforación por técnica de erosión. El procesado de las materias óseas viene muy condicionado por sus formas anatómicas naturales, razón por la cual solo un rango restringido de variables de transformación con cambios mínimos a través del tiempo es esperable. No obstante, numerosos especialistas invocan al valor cultural conferido por la comunidad como el elemento clave en la selección de materias primas más que estas limitaciones aludidas sobre la forma de la materia prima. Por ello, existen algunos ejemplos en donde ha habido poco cambio a lo largo del tiempo en la selección de las materias primas a pesar de haber habido variabilidad en la disponibilidad de especies animales. Como resultado de esto el estudio de los tres tipos de técnica de (manufacturado por desgaste) se torna más interesante. Estas técnicas no están presentes en la región en todo momento. Algunas de ellas aparecen en material óseo trabajado en Rumania y zonas adyacentes a principios del Neolítico pero desaparecen igual de rápido (bipartición por abrasión) o solo lo hacen de forma esporádica a principios del Calcolí-

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tico (perforación y segmentación con fibra). Basándonos en análisis experimentales de las tres técnicas de procesado y comparando ello con los conjuntos arqueológicos, nuestro estudio pretende incorporar todas las variables relevantes (gestos tecnológicos, tiempo requerido para cada operación, herramientas utilizadas, etc.) y evaluar si estas representan una innovación auténtica en el modo en que fueron procesados los materiales óseos.

PALABRAS CLAVE: EUROPA SUDORIENTAL, RUMANIA, NEOLÍTICO, APROVECHAMIENTO DEL HUESO, OPCIONES TECNOLÓGICAS, TRADICIONES CULTURALES

INTRODUCTION

The importance of cultural factors in the technical choices of prehistoric communities has already been emphasized by numerous specialists (e.g., Dobres, 2000, 2010; Luik & Maaldre, 2007; Stark *et al*., 2008; Choyke, 2009, 2013, 2014; Choyke & Daroczi-Szabo, 2010; etc.). As Lemonnier (1992) observed, technology is not only one means by which human communities act upon their physical environment, but also the act of manufacturing something is a social productions in itself. It concerns the active involvement of people in the creation of their material world in a continuous process, in which "*ancient technologies materialized prevailing worldviews, social values and cultural attitudes about how to live in and act on the world*" (Dobres, 2010: 106). These conditionings, Bourdieu (1977) called them *habitus* - a form of social pressure to maintain the identity of the community, direct all the stages of the *chaîne opératoire*, from the selection strategies for raw materials to the choice of technological transformation schemes and the stages of utilization, curation and recycling.

Thus, technical choice in bone-based technologies underwent only insignificant modifications over long periods of time, despite changes in animal species availability (e.g., Choyke *et al*., 2004; Luik, 2011). The innovations seem to reflect 'social quakes' within the communities, generating cracks and discontinuities, many of them identifiable at the archaeological level (but they also represent a kind of agency by which people at the time could express certain changes in their social identities). This opinion is widely shared by specialists (e.g., Creswell, 1994; Choyke, 2005; Roux, 2010, 2013). The agency of objects and their manufacture is very well described by Wobst (1999: 126): "*each new tool modifies the social field. It reshapes the template for what is thought or known to be practical. It modifies the reference points*".

Starting with these opinions, the purpose of this paper is to explore and identify the transformations of the osseous industry throughout the North-Danubian Neolithic, with a particular focus on three types of the 'manufacture-by-wear' technique: bipartition by abrasion, segmentation with fibre and perforation by wear technique. The goal is to understand the factors that defined the use of the material manufacture-by-wear techniques as opposed to other possible techniques for processing artefacts. We will also try to identify, if possible, the moment these manufacture-by-wear techniques appeared and were abandoned in the discussed region. Following this path, we wish to answer the question: can these 'manufacture-by-wear' techniques be used as indicators of particular cultural/social phenomena in the past? When these new approaches are developed or appear in the region (with the beginning of the Early Neolithic), they are accompanied by other markers of socio-economical change e.g., small agricultural farms, rituals centred upon the female symbol and *Spondylus* adornments of Mediterranean origin (Perlès, 2010) and therefore represent changes in manufacturing traditions even at the conservative household level.

TERMINOLOGY AND METHODOLOGY

Definitions

The method of bipartition by abrasion was first identified by Poplin (1974) and detailed in other papers. Its presence is attested widely across the European continent (Sénépart, 2004; Sidéra, 2004; Choyke, 2007; Vitezović, 2013a) (see Table 1).

Wear technique	Region	Culture/ Period	Dating (BC)	Sites	Bone	Species	References
Bipartition by abrasion	Spain	Neolithic I	c. 5600-4500	Cova de l'Or	Metapodial	Ruminant	Marti Oliver, 1993; Pascual Benito, 2016
				Cova de la Sarsa	Metapodial	Ruminant	
				La Draga	Metapodial	Ruminant	Bosch *et al*., 2000; Pascual Benito, 2016
	France	Rubané	c. 5500-4700	Cuiry-lès-Chaudardes	Metapodial	Ruminant	Sidéra, 2012
				Berry-au-Bac	Metapodial	Ruminant	Sidéra, 1995
				Bucy-le-Long "La Fosselle"	Metapodial	Ruminant	Sidéra, 2008
				Etigny "Le Brassot-Est"	Metapodial	Ruminant	
				Missy-sur-Aisne "Le Culot"	Metapodial	Ruminant	
		VSG	c. 4950-4650	Villeneuve-la-Guyard	Metapodial	Ruminant	
				Jablines "La Pente de Croupeton"	Metapodial	Ruminant	
				Mareuil-lès-Meaux	Metapodial	Ruminant	
		Chasséen	c. 4200-3500	Fontbrégoua	Metapodial	Ruminant	Sénépart, 1984, 2004
	Italy	SMP	c. 4950-4050	Arene Candide	Metapodial	Ruminant	Maggi *et al*., 1997
	Switzerland	Cortaillod	c. 3900-3500	Auvernier-Port	Metapodial	Ruminant	Murray, 1979
				Muntelier/Fischergässli	Metapodial	Ruminant	Sidéra, 2000a
	Austria	LBK	c.5500-4500	Asparn/Zaya-Schletz	Metapodial	Ruminant	Felhmann, 2010
	Hungary	Starčevo-Criş-Körös	c.6200-5300	Ecsegfalva 23B	Metapodial	Ruminant	Choyke, 2007
	Serbia	Starčevo-Criş-Körös	c.6200-5300	Starčevo-Grad	Metapodial	Ruminant	Vitezović, 2013a
	Macedonia	Anzabegovo-Vršnik II-IV	c.5800-5200	Madzhari	Metapodial	Ruminant	Sidéra, 2012
	Grecia	Early Neolithic	c. 6500-5800	Giannitsa	Metapodial	Ruminant	Sidéra, 2012
		Proto-Sesklo	c. 6500-6000	Nea Nikomedeia	Metapodial	Ruminant	Stratouli, 1999; Sidéra, 2012
	Bulgaria	Early Neolithic	c.6100-5800	Kovačevo	Metapodial	Ruminant	Sidéra, 2012
	Romania	Starčevo-Criş-Körös	c.6200-5300	Negrileşti	Metapodial	Ruminant	Beldiman *et al*., 2012
				Şeuşa – "La cărarea morii"	Metapodial	Ruminant	Beldiman and Sztancs, 2013
Segmentation with abrasive fibres	Spain	Neolithic I	c. 5600-4500	Cova de la Sarsa	Femur; Diaphysis	Ruminant and Indeterminate	Llobregat *et al*., 1981; Sénépart, 1984; Pascual Benito, 1996
				Cova de la Cendres			
				Fosca			
	France	Rubané	c. 5500-4700	Cuiry-lès-Chaudardes	Diaphysis	Indeterminate	Sidéra, 2005, 2012
				Berry-au-Bac	Diaphysis	Indeterminate	Sidéra, 1995
				Ensisheim	Diaphysis	Indeterminate	Sidéra, 2000b
		Chasséen	c. 4200-3500	Wettolsheim	Diaphysis		Sidéra, 2000b
	Hungary	Starčevo-Körös-Criş	c.6200-5300	Ecsegfalva 23B	Diaphysis	Indeterminate	Choyke, 2007
	Serbia	Starčevo-Körös-Criş	c.6200-5300	Starčevo-Grad	Diaphysis	Indeterminate	Vitezović 2013a
	Bulgaria	Early Neolithic	c.6100-5800	Kovačevo	Diaphysis	Indeterminate	Sidéra, 2005, 2012
	Romania	Boian	c.5000-4500	Radovanu	Tibia	*Ovis/Capra*	Mărgărit *et al*., 2014b
				Issacea	Diaphysis	Indeterminate	Micu, 2004
		Hamangia	c.5200-4500	Cheia	Femur; Diaphysis	*Ovis/Capra/ Capreolus*	Voinea *et al*., 2014
Perforation by wear technique	Hungary	Starčevo-Körös-Criş	c.6200-5300	Ecsegfalva 23B	Diaphysis		Choyke, 2007
	Bulgaria	Early Neolithic	c.6100-5800	Kovačevo	Diaphysis	Indeterminate	Sidéra, 2012
	Serbia	Starčevo-Körös-Criş	c.6200-5300	Čoka-Kremenjak	Diaphysis	Indeterminate	Vitezović, 2013a, 2013b
				Starčevo-Grad			
				Vizić-Golokut			
				Grivac			

TABLE 1

Examples of the use of wear techniques in the European Neolithic.

Sheep (*Ovis aries*), goat (*Capra hircus*) or roe deer (*Capreolus capreolus*) metapodials are the raw materials that are always used. The cortical bone is divided with the purpose of obtaining of two standardized blanks with an artificial shape and rectangular section. Thus, the blanks have four sides. The surface of two of them is completely flat, entirely covered with parallel abrasion marks lying obliquely along the long axis of the piece. The abrasion marks are coarse, showing that a strongly abrasive stone was used to wear down the cortical layer and accelerate the division of the bone. The other two sides reveal the bone's natural structure including the medullary cavity and the diaphysis wall. Such grinding of the articular ends also produces a decorative shape at the same time. The method is associated with pointed tools and decorative pins.

The second type of the 'manufacture-by-wear' technique involved the production of regular, drilled perforations with circular morphologies and cylindrical sections. With this type of perforation, a preform preserves a perforation with completely smooth walls and with continuous fine drilling striations along the perforation wall. Small fragments of bone associated with this technique have been found. They have all the same wall characteristics and a cylindrical morphology. The presence of these small waste pieces demonstrate that the instrument used to make the perforation was hollow with a cylindrical morphology itself.

Segmentation with abrasive fibre was used in two transformative technological schemes. In the first scheme it was applied on long bones belonging to large and medium size species such as cattle (*Bos taurus*), aurochs (*Bos primigenius*), red deer (*Cervus elaphus*) and wild boar (*Sus scrofa*). The objective was to remove the epiphysis by using this procedure which produced a groove with polished concave walls and long, fine striations developing transversally to the long axis of the blank. Moreover, the procedure has been identified on debitage waste, but not on diaphyses, due to their thorough transformation in the shaping stage. In the second scheme, this technique was used to make rings. Here, the technique was used on diaphysis from medium sized ruminants (*Ovis aries*/*Capra hircus*/*Capreolus capreolus*). To visualize the width of the intended blanks, a delineation procedure was applied by sawing with a lithic tool. In this way, a groove was drawn around the entire circumference of the bone. The process continued with segmentation by sawing with a fibre. The groove was also used to stop the thread from sliding until the groove was sufficiently deep to hold it in place. The technique produced a series of blanks, close to being finished, with diameters predefined by the size of the long bone diaphysis.

Methodology of analysis

To gather information about these techniques we integrated three types of data: 1) direct analysis of the archaeological material, 2) published technological records from other archaeological assemblages (Table 1) and 3) our own experimental approach. For the purposes of this research, we identified diagnostic pieces such as preforms, blanks and manufacturing waste mostly from the faunal assemblage itself, rather than finished pieces. The artifacts were studied at a macroscopic level where the correct characterization of technological marks is particularly important. Based on this, the succession of manufacturing gestures was reconstructed to visualize the transformation from block of unworked raw material to finished object. In addition, the archaeological and experimental marks were analyzed with an Olympus stereo-microscope (magnification up to 90X), and a Keyence VHX-600 digital optic microscope using lenses of variable strength between 30X and 100X.

Bone replicas were produced based on the identified data on actual archaeological pieces. These replicas provided an overview of the variable techniques used in processing osseous materials. A descriptive chart including all the stages of the operational scheme was used providing detail on raw material type, the time necessary for each type of operation, the tools we have worked with, and the results obtained for each operation (macro-marks). However, we have an obligation to specify that the necessary time commitment is always relative because none of the participants can claim the know-how of people who have been doing these crafts since childhood. The time it takes for us to progress through these actions is likely to be radically different than the time taken by an adult in any of these Neolithic societies. Consequently, it takes as many experiments as possible to gain experience and improve our workload. Also, we did not always have access to identical bones types as those used by the Neolithic communities. All these details highlight that the results of any experimental approach should be accepted with caution.

The purpose for the seriation of these charts is to create a referential database which, by constantly gathering information, related to all the variables involved in the implementation of the three 'manufacture-by-wear' techniques. Unfortunately, the experiment gives us a truncated picture of the prehistoric community technology: it can show us what was done but not why it was done. There are many ways to solve most technical requirements and we can imagine that the prehistoric craftsmen tried all these technological innovations and most of them failed and were abandoned. It is impossible for us to reconstitute all the ways that finally led to the adoption of these three technological solutions.

Archaeological assemblage

The settlement of Măgura-Buduiasca (Figure 1) is located in southern Romania, on a lower terrace of Teleorman river, within the south-east part of Măgura village. It was discovered in 2001 and archeologically researched during 2001-2008. The dimensions are approx. 850 x 350 m on the east-west and north-south axes, with a surface of almost 30 ha. Throughout the researched surface of the site, which sums to 400 m^2, the archeological levels do not present the same consistency. The stratigraphic analysis of the relevant profiles from the archeological sections and samplings revealed elements that enable temporal relations between the different Neolithic levels to be specified. From the perspective of absolute chronology, a series of 32 ^{14}C data outlines the evolution of this settlement: Starčevo-Criș I – c. 6000-5900 cal BC, Starčevo-Criș III – c. 5800-5700 cal BC, Dudești – c. 5500-5300 cal. BC and Vădastra – c. 5200-5000 cal BC. (Table 2). During the archeological excavations assemblages that belong to the entire sequence of the Neolithic were examined. After analyzing their structure, the type of inventory and the manner in which the different categories of materials were associated, they were interpreted as different constructions, including dwellings, pits and waste areas, and deposits with ritual character. The inventory of the assemblages generally consists of ceramic fragments,

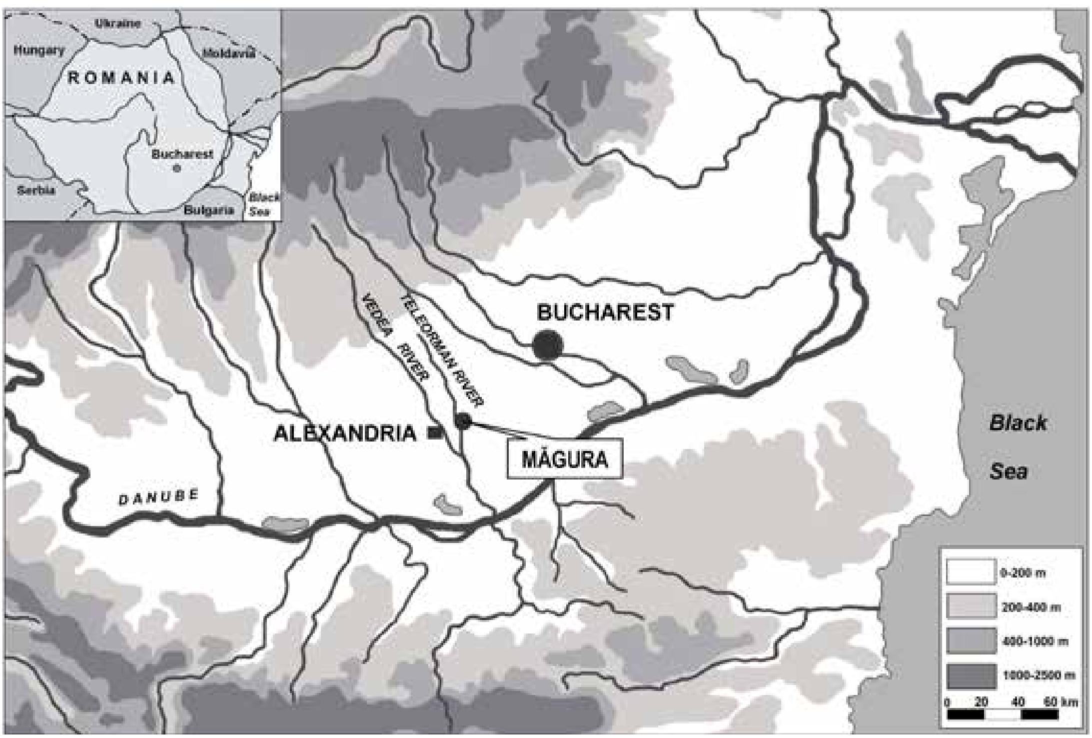

FIGURE 1
Location of the Măgura-Buduiasca settlement. Adapted after Balasse *et al*. (2013; fig. 1).

Lab. No.	*Date BP*	*±*	*Cal BC 1σ*	*Sample material*	*Level*	*References*
Poz-52552	7110	40	6030-5920	Animal bone	Starčevo-Criş I	Mirea, 2005, 2011; Walker & Bogaard, 2011; Thissen, 2012, 2013; Balasse *et al*., 2013; Bălăşescu, 2014; Evin *et al*., 2015
Poz-52554	7100	50	6030-5910	Animal bone	Starčevo-Criş I	
UBA-9630	7107	29	6020-5930	Animal bone	Starčevo-Criş I	
Poz-52553	7060	40	6000-5900	Animal bone	Starčevo-Criş I	
UBA-9629	7031	31	5990-5890	Animal bone	Starčevo-Criş I	
UBA-18097	6970	27	5900-5800	Animal bone	Starčevo-Criş I	
UBA-18098	6959	28	5890-5790	Animal bone	Starčevo-Criş I	
Wk-14436	6896	61	5850-5720	Animal bone	Starčevo-Criş III	
OxA-21405	6868	38	5800-5710	Barley grain	Starčevo-Criş III	
Wk-14437	6833	53	5760-5660	Animal bone	Starčevo-Criş III	
OxA-21406	6831	37	5740-5670	Barley grain	Starčevo-Criş III	
Wk-14435	6784	56	5720-5640	Animal bone	Starčevo-Criş III	
OxA-21407	6767	38	5710-5630	Wheat grain	Starčevo-Criş III	
OxA-21403	6761	36	5710-5630	Barley grain	Starčevo-Criş III	
OxA-21404	6278	37	5310-5220	Barley grain	Starčevo-Criş III *	
OxA-16636	6543	37	5530-5470	Animal bone	Dudeşti	
OxA-16633	6497	35	5510-5380	Animal bone	Dudeşti	
OxA-16637	6484	37	5490-5380	Animal bone	Dudeşti	
OxA-16630	6463	40	5480-5370	Animal bone	Dudeşti	
OxA-16634	6454	39	5480-5370	Animal bone	Dudeşti	
OxA-16641	6415	45	5470-5360	Animal bone	Dudeşti	
OxA-16969	6371	37	5470-5310	Animal bone	Dudeşti	
OxA-16635	6354	37	5380-5300	Animal bone	Dudeşti	
OxA-28791	6238	34	5310-5080	Animal bone	Vădastra	
OxA-16632	6260	35	5300-5210	Animal bone	Vădastra	
OxA-24693	6260	34	5300-5210	Animal bone	Vădastra	
OxA-16631	6130	40	5210-4990	Animal bone	Vădastra	

TABLE 2

Radiocarbon dates for the cultural levels of Măgura-Buduiasca settlement. * *This date corresponds to the Vădastra level.*

animal bones, shells valves, stones, bone and flint tools, anthropomorphic and zoomorphic figurines, and adornments.

The bipartion by abrasion technique appears in the oldest Starčevo-Criș level, but had disappeared at the Dudești level and does not reappear in subsequent levels (Table 3). This procedure seems to be replaced by pointed tools produced on ribs, obtained by longitudinal bipartition using diffuse direct percussion or longitudinal scraping. One fragment of caprine distal epiphysis metacarpus bone is extremely interesting. It most likely represents waste from manufacturing (Figure 2a) (Mărgărit *et al*., 2014a). Only one epiphysis is preserved and a small part of the diaphysis wall. This piece eloquently illustrates how these points were shaped by bipartition. Both the dorsal and palmar faces of the diaphysis were heavily abraded (Figures 2b, d) producing a rectilinear appearance. This action continued until the two preforms were detached from each other. A block of this type, entirely preserved, is mentioned from the site of Starčevo-Grad – Serbia (Vitezović, 2013a; fig. 12). Returning to Măgura-Buduiasca, the bipartition was noticed on a few caprine metapodials (seven specimens) transformed into pointed tools (Figure 2c). The technique was observed on seven other pieces with different fragmentation degrees. The possibility cannot be excluded that these objects might actually have been finished pieces, more precisely pointed tools.

This technical procedure is present throughout the Early Neolithic in the Balkans (e.g., the settlements of Kovačevo – Bulgaria (Sidéra, 2012; fig. 25), Madzhari – Macedonia (Sidéra, 2012; fig. 25), Starčevo-Grad – Serbia (Vitezović, 2013a) or

Period	Culture	Dating (BC)	Bipartition by abrasion			Perforation by wear technique			Segmentation with abrasive fibre		
			Species	Bone	N° pieces	Species	Bone	N° pieces	Species	Bone	N° pieces
Early Neolithic	Starčevo -Criş	c.6200-5300	*Ovis/Capra/ Capreolus*	Metapodial	15	Indeterminate	Diaphysis	5	*Bos taurus*	Metatarsus	3
										Metacarpus	3
										Femur	1
										Humerus	1
										Tibia	1
									Bos primigenius	Metacarpus	1
									Cervus elaphus	Tibia	1
									Indeterminate	Diaphysis	12
Middle Neolithic	Dudeşti	c.5500-5000	-	-	-	Indeterminate	Diaphysis	12	*Bos taurus*	Femur	7
										Metatarsus	4
										Metacarpus	1
										Tibia	1
										Radius	1
									Ovis/Capra	Femur	5
										Humerus	2
									Sus sp.	Femur	3
										Tibia	1
									Indeterminate	Diaphysis	28
										Femur	1
Early Chalcolithic	Vădastra	c. 5000-4800	-	-	-	Indeterminate	Diaphysis	2	Indeterminate	Diaphysis	4
									Cervus elaphus	Tibia	1

TABLE 3

Descriptive table of the analyzed pieces from the Măgura-Buduiasca settlement worked osseous assemblage.

Ecsegfalva 23B – Hungary (Choyke, 2007)). It is attested north of the Danube, in Romania, by example at Negrileşti (Beldiman *et al.*, 2012) and Şeuşa (Beldiman & Sztancs, 2013).

As with the previous technique, the perforation by wear appears in this region in the Early Neolithic. Unfortunately, archaeologists often treat the perforated bone pieces only in a general sense without detailing how the perforations were produced. Moreover, the debris generated by perforation activity (round debris with a medium diameter from 6 to 9 mm) (Figures 3a-h), the key for deciphering this technique, were not recovered during the excavations due to their small dimensions. The small objects tend to be lost where no sieving or flotation sampling is used during the excavation, methods not very often applied especially in the older archaeological excavations. Moreover, archaeologists did not always recognize the special potential of these pieces (even if they recovered them), for identifying the technical choices of the studied prehistoric communities. Belt elements (Figures 3i, j) or rings (Figures 3k, l) could be manufactured from these preforms. Certainly, such examples should be far more numerous but, for the moment, without better excavation and reporting techniques, in the Romanian Neolithic this perforation type is only attested at Măgura-Buduiasca. Two perforated pieces come from the Starčevo-Criş level alongside another three perforation remains. In the Dudeşti level, there are nine pieces where the marks of this type of perforation technique are preserved, as well as three pieces of waste from perforation work. Finally, two items from the Vădastra level also preserve this type of perforation (Table 3). In the wider area of Starčevo-Körös-Criş culture, this perforation procedure was identified at Čoka-Kremenjak, Starčevo-Grad, Vizić-Golokut and, probably, Grivac (Vitezović, 2013a, 2013b; fig. 11), while Choyke (2007) identified it at Ecsegfalva 23B.

The appearance of segmentation with an abrasive fibre is connected, again, with the Starčevo-Körös-Criş culture (Sidéra, 2012; fig. 19) and is mentioned at Starčevo-Grad (Vitezović, 2013a), Kovačevo (Sidéra, 2012) and Ecsegfalva 23B (Choyke, 2007). As we noted in the methodological section, the use of this segmentation technique at Măgura-Buduiasca is connected to two different

FIGURE 2

Archaeological evidence for the bipartition by abrasion technique: debitage waste (a); details of the abraded surface (b), (d); finished items (c). (Măgura-Buduiasca, Starčevo-Criș I level). (Photo by M. Mărgărit).

objectives: 1) dividing the diaphysis of large bones so that the cortex of the bone wall could be used subsequently for manufacturing (Figures 4a-d) and 2) for the production of a series of rings preserving the volume of the blank (Figures 4e-g). In the Starčevo-Criș level, the division of the diaphysis is attested by 20 specimens although rings were obtained in only three cases. For Dudești levels, the number of examples increases to 38 cases in which the epiphysis was eliminated and 16 rings were obtained (at different stages of manufacture – from marking out future rings, to creation of segmented blanks and, finally, finished pieces). For the final Vădastra level three rings and two segmented diaphysis were identified (Table 3).

Experimental replica

We must specify that all the bones in our experiments were processed either immediately after the slaughter of the animal or have been frozen until the time of processing (in order not to lose water from the tissue, which would make the bone more breakable). None of the bones were heat treated because there is big difference between cooked bone and green bone in the way it reacts to technological processing.

Bipartition by abrasion

For the experimental reconstruction of the operational chain, a single metapodial from a 12 month old goat (*Capra hircus*; Figure 5a) was used. Choosing this type of bone was not accidental, which is most often found in archaeological assemblages for the bipartition by abrasion technique (see *Methodology section*). Unfortunately, we could not acquire a bone from an adult specimen as were used in the Neolithic. Bones from younger specimens are easier/faster to process but the resulting blanks are less resistant. Again, we emphasize the limits of the archaeological experiment, especially for restoring the processing times for each technique.

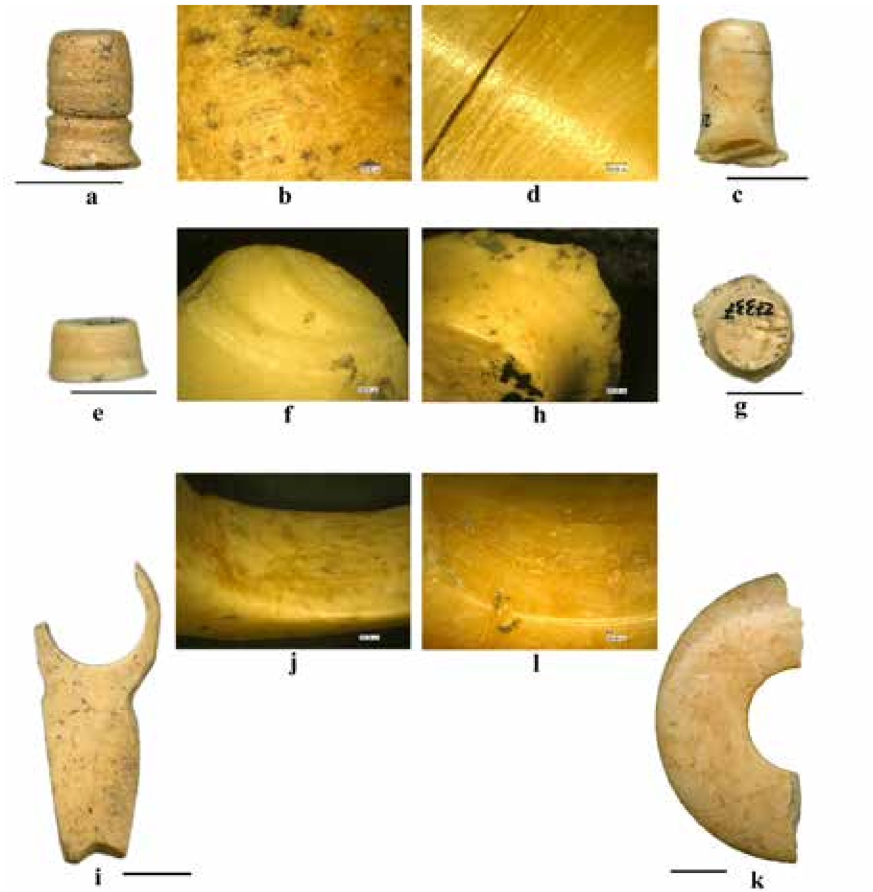

FIGURE 3

Archaeological evidence for the perforation-by-wear technique: perforation wastes (a), (c), (e), (g); details of the wear technique (b), (d); side-slips from the perforation pattern (f); macroscopic view of the perforation wall (h); belt element (i); details of the perforation (j), (l); ring (k). (Măgura-Buduiasca: (a), (c) – Starčevo-Criș I level; (e), (g), (i), (k) – Dudești level). (Photo by M. Mărgărit).

Using linear friction (Figure 5b), the method of bipartition by abrasion was applied by alternative abrasion of both dorsal and plantar surfaces until the medullary cavity was reached (Figure 5c-f). A very abrasive stone was used over which water was periodically poured. The procedure was lengthy and took 1 hr 45 minutes. It did not require constant physical effort but rather a controlled uniform movement. At the end of this transformation scheme, two regular blanks were obtained, both with a rectangular cross-section (Figure 5h) and two flat sides, close to the form of the future final object. The parallel abraded striations, generally lying obliquely to the long axis of the piece, entirely cover the processed surface. This manner of obtaining blanks requires greater time investment initially and less effort for the second part of the operation: the shaping. Thus, one of the halves was detached very easily with a direct percussive blow on the epiphysis. Then this half metapodial was rapidly transformed (4 minutes) into a point by abrasion at the active end, to provide convergence of the sides (Figure 5g).

Perforation by wear technique

The manner of how this technique was applied raised some procedural problems, the only certainty being the fact that the holes were produced by a non-lithic drill head that was hollow on the inside (thus creating special waste from perforation), perhaps with the addition of an abrasive material such as sand that created a strong macroscopic polish

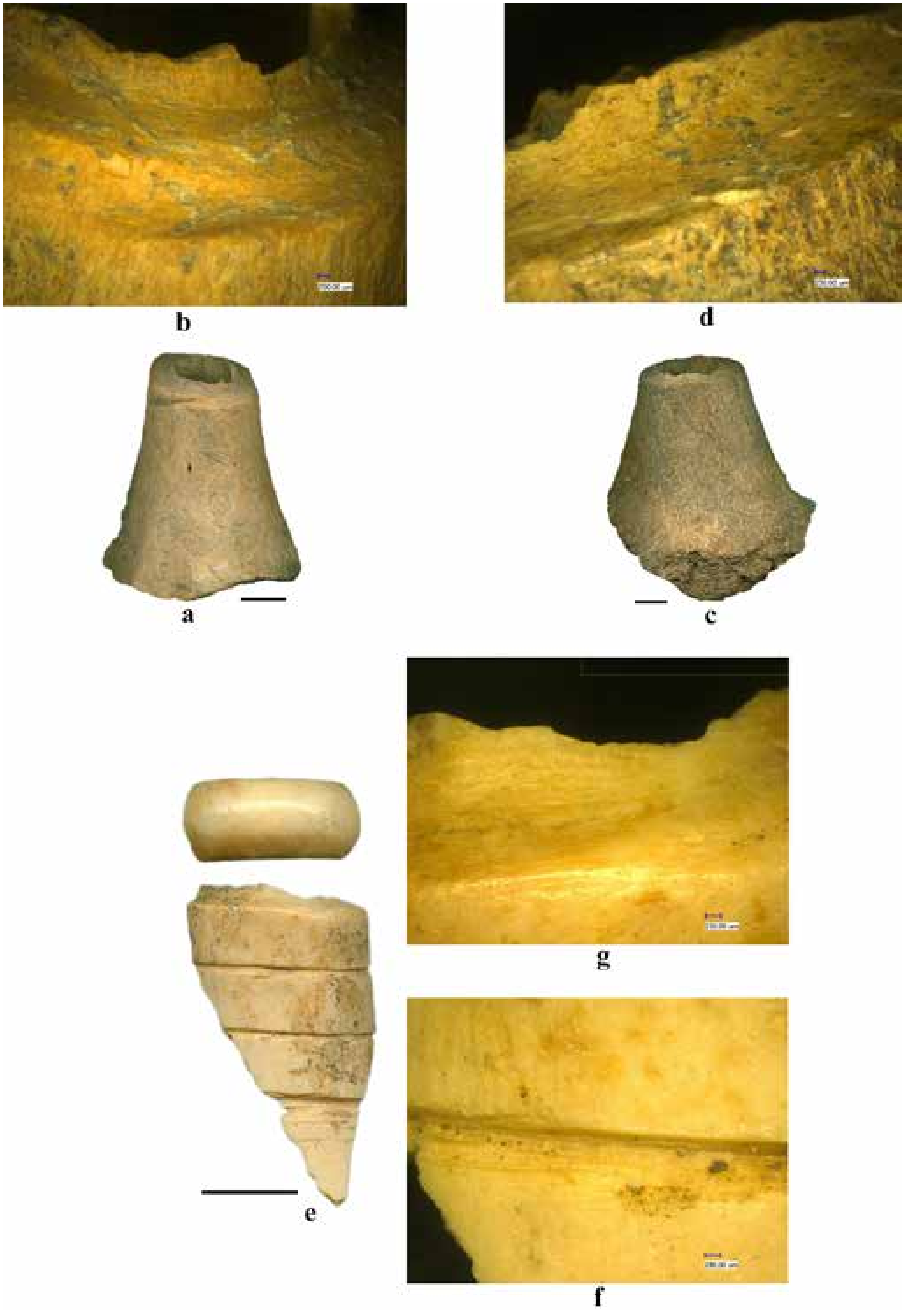

FIGURE 4

Archaeological evidence for the method of segmentation with abrasive fibre: epiphysis eliminated by segmentation (a – cattle metatarsus), (c – cattle femur); details of the segmentation groove (b), (d); blank and finished item illustrating the technique of segmentation for rings produced on blanks in volume (e); technique of delineation using a lithic tool (f); detail of the segmentation groove (g). (Măgura-Buduiasca, Dudești level). (Photo by M. Mărgărit).

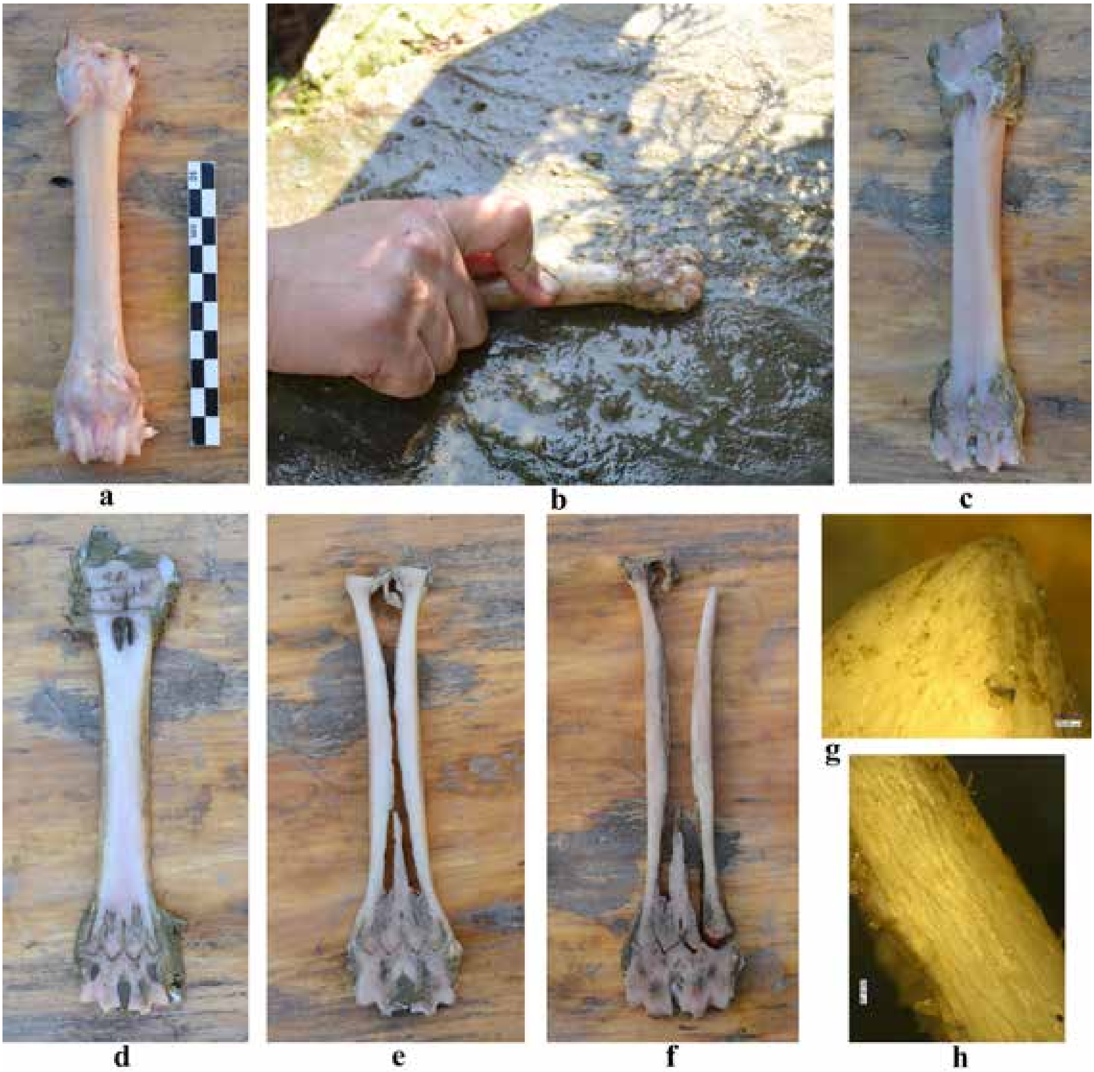

FIGURE 5

Experimentation of the bipartition method by abrasion: stages of the processing procedure (a)-(f); details of the abraded surface (g), (h). (Photo by M. Mărgărit).

visible under magnification. The material which seemed best adapted to this procedure was reed stems with the occasional addition of sand and water. During this work, the hand glides down to the bottom of the tubular reed, the length of the reed determining the amplitude of the movement (Figure 6a). In the first stage, this technique was used on a long goat bone that had been longitudinally fractured. It was clear why the perforation was produced on a flat blank: the rod would become blocked or slip in the medullary cavity so that the channel within which the perforation by wear technique evolved cannot get started. Even under these conditions, it was very difficult to hold the stick steady within the form of the initial channel. Such side-slips are obvious on numerous pieces of perforation waste (Figure 7f). The perforation work was finished in 50 minutes, and the result was a perfectly cylindrical perforation (Figures 6b-d) and a small piece of perforation waste (Figure 6e). This waste had to be detached as it comprised a small part still trapped in the material block because the rotation procedure could no longer be continued and appearing like a small accident. This mark may also be seen on archaeological objects. The striations and polish developed on the perforation walls, both on preforms (Figure 6f) and on the resulting debris, are similar to those identified on archaeological objects.

In the second stage, the technique was used on a cattle femur (*Bos taurus*) (Figure 7a). The bone was fractured using diffuse direct percussion and one of the resulting longitudinal splinters was selected from the diaphysis wall. A rod with an opening of 11 mm diameter could be used to create a perforation with a larger diameter (9 mm). The perforation work extended over a period of 2 hours and was extremely exhausting (well, for 21st century soft urban dwellers anyway) (Figures 7b-d). The results and observations are similar to those of the previous technical example (Figures 7e-g).

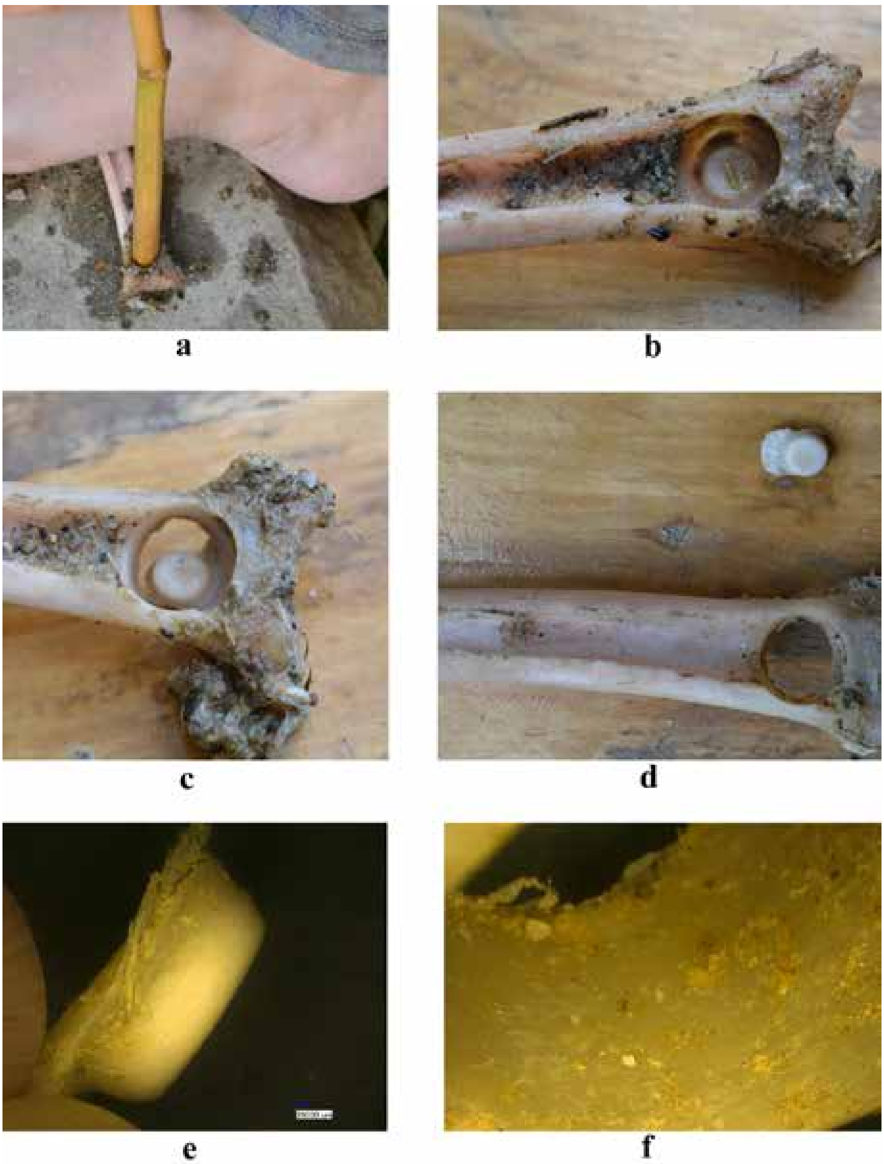

FIGURE 6

Experimentation on the perforation by wear technique on a metapodial goat: stages of the technological processing (a)-(d); perforation waste (e); detail of the perforation (f). (Photo by M. Mărgărit).

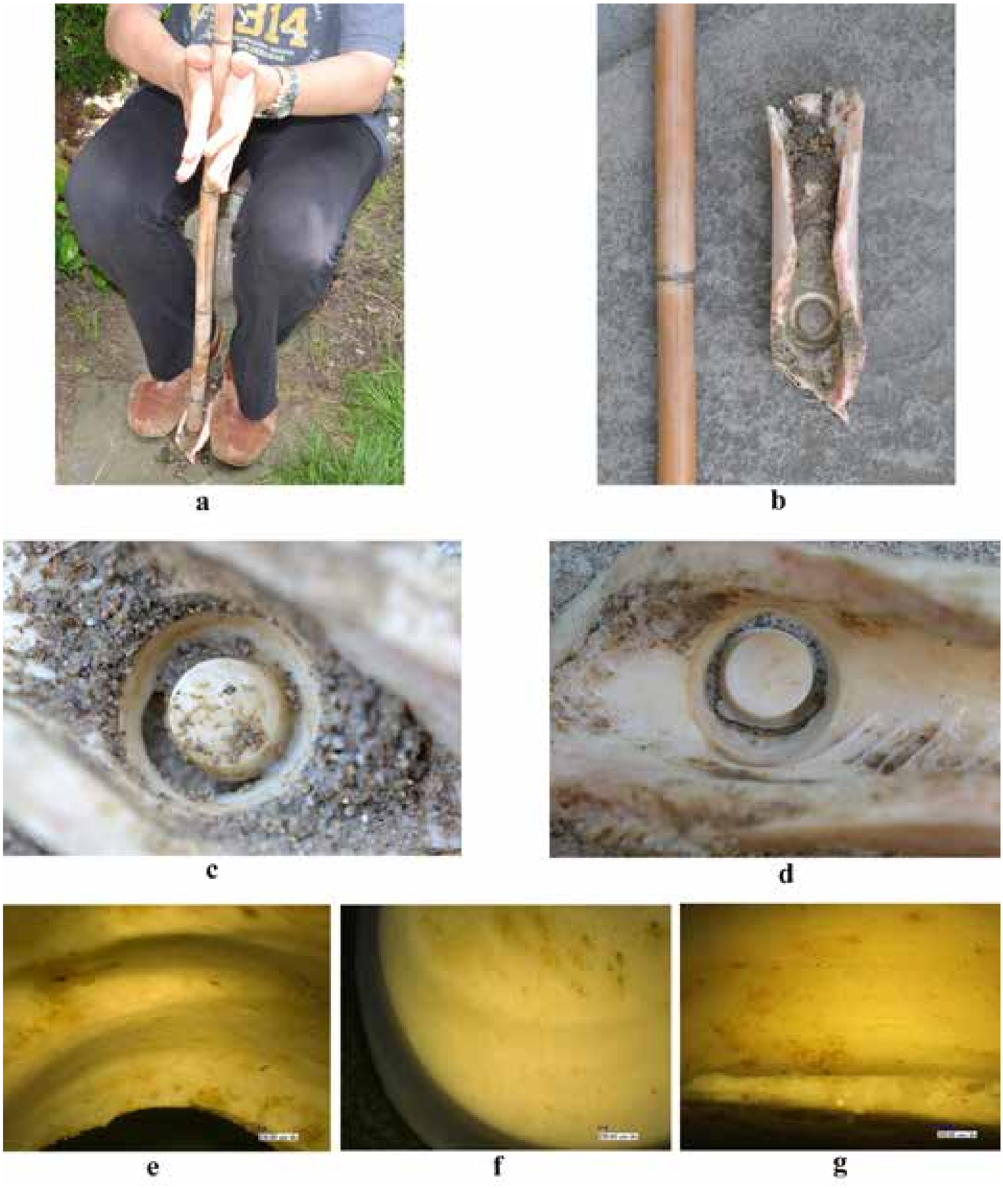

FIGURE 7

Experimentation on perforation by wear technique on a cattle femur: stages in the technological processing (a)-(d); detail of the perforation (e); side-slips from the perforation pattern (f); wall of the perforation waste (g). (Photo by M. Mărgărit).

Segmentation with abrasive fibre

The first segmentation procedure was used on a pig (*Sus domesticus*) femur (Figure 8a). The choice of this blank was constrained by availability, even though we are conscious of the fact that modern pig has less dense long bones (we again return to the limits of the experimental approach).

The purpose was the removal of epiphysis using sawing with an abrasive fibre, applied at both epiphyses. A thread made of vegetal fibre (hemp) was chosen which can be acquired already prepared. This type of material was chosen because it is very close to a plant fibre the Neolithic communities used and, in addition, is quite easy to obtain. Wet sand in combination with the string was employed (Figure 8b). The time necessary to remove each epiphysis was about 20 minutes. The procedure is quite difficult during the first 5 minutes because the groove is not yet formed and the string slides and the trajectory must be straightened. Once the groove is sufficiently deep the method becomes very efficient. However, the segmentation cannot be finalized only by this procedure. At the end the bone must be detached by bending the epiphysis at the groove until it snaps off. The result appears as a snap flake that was also observed on the archaeological pieces. The bending cannot be applied prematurely, otherwise there is a possibility of an accidental crack appearing, creating an irregular fracture. The fibre of hemp broke many times and needed replacement. At the end, this work resulted in a blank and two pieces of debitage waste (Figure 8c). Under a microscope (50x magnification) the

FIGURE 8

Experimentation on the segmentation procedure with plant fibre: stages in epiphysis elimination (a)-(c); processing rings by segmentation (d); detail of the segmentation groove (e). (Photo by M. Mărgărit).

development of certain technological marks similar to those found on archaeological pieces can be seen: a polished wall with a slightly concave morphology and fine striations located transversally to the long axis of the piece (Figure 8e).

In a second stage of experimentation, the procedure for obtaining the rings (Figure 8d), following manufacturing stages identified on archaeological pieces was used: the delineation of the grooves with lithic tools with the final detachment of the epiphyses carried out by plant fibre string (the same type of hemp string). A sheep (*Ovis aries*) femur was used as the raw material. The procedure was quite quick and each one of the segmentations took approximately 7 minutes.

RESULTS AND DISCUSSION

Following the experiments and compared to the other techniques, it was very clear that a somewhat longer time is needed for the bipartition by abrasion of osseous blanks. However, among the examined assemblage, two other debitage methods by bipartition, producing the same results, were identified, the processing of two flat blanks which can be can further transformed into pointed tools. The alternative techniques where the debitage method was used are 1) the double grooving and 2) the indirect percussion. For this reason it was proposed that the technical scheme for these two procedures be reconstructed by experiment in order to permit a comparison with the previous experimental results. First, the bipartition by double grooving was reproduced. It required initiation of two grooves by unidirectional longitudinal movements using a *burin* type tool (Figure 9a). When the medullary cavity was reached the bony cortex was ready for bipartition. Bipartition of the two blanks was made using indirect percussion, this case requiring special attention to the force that hit the intermediary tool to avoid accidental cracks (Figure 9b). The result was two symmetrical blanks, obtained after approximately 40 minutes of work (Figure 9c). These blanks can be transformed into pointed tools quite rapidly by a combination of different techniques (scraping, abrasion, scraping + abrasion etc.). In the second case, bipartition by indirect percussion was reproduced, an action which produced usable blanks very quickly but which requires good control of the striking force otherwise the bone may be fragmented randomly (Figure 9d). There were a number of failures until the necessary strength to accomplish bipartition was determined, and two intact blanks were obtained. In the Early and Middle Neolithic assemblages of the studied region, all three methods coexist and no preference was noticed for any one.

The second technological procedure was the creation of a perforation through wear. It is slightly different from the previous technique. It is true that a perforation can also be created by bifacial rotation of a lithic tool. The operation takes approximately 30 minutes on the diaphysis of a bone of a large sized mammal (e.g. femur and metapodial of *Bos taurus*). However, this technique does not produce perforations uniform enough on both sides and with a regular diameter. In our opinion the disappearance of the procedure is connected with the disappearance of these decorative elements (belt elements and rings, Figure 3i, k) at the beginning of the Chalcolithic and by their replacement with other decorative elements which allow a faster technique for perforations.

For the third technique, epiphyses as debitage waste will be discussed. Using a hemp fibre string is a much faster procedure compared to segmentation by sawing using a lithic tool. Moreover, it does not require sustained physical effort, but rather constant bidirectional movement allowing the wear to develop. The procedure of epiphysis removal by sawing with a lithic tool has not been identified on bones from some large/medium sized mammals within the archaeological collections. The alternative procedure with similar results is direct percussion (Figure 9e). All that is needed is a massive lithic tool with a sharp edge and the application of a short, powerful strike. With only a couple of strikes a crack can be initiated allowing the epiphysis to be detached. The action can be continued with hits aimed around the entire circumference of the diaphysis or with detachment by bending where the risk still exists that the bone will break in an irregular manner, compromising the blank. The type of hammer appears to be very important because, in our own experiments, if a rounded hammer is used for diffuse percussion the result is the development of multiple longitudinal cracks creating fragments from which flat blanks are obtained (Figure 9f). In the case of rings, there is an obvious reason for using the segmentation procedure with abrasive fibre based string in preference to segmentation by percussion or even sawing with a lithic tool. Crafts-

FIGURE 9

Experimentation on the bipartition and segmentation methods: stages of bipartition by double grooving (a)-(c); bipartition by indirect percussion (d); direct percussion (e); diffuse direct percussion (f). (Photo by M. Mărgărit).

people wanted to obtain regular blanks, a necessary condition for creating a desired aesthetic impact, with investment of minimum effort in the shaping stage. This is probably the reason why this procedure endured over the time. Thus, this manner of obtaining the rings is still present in the Early Chalcolithic assemblages of Radovanu (Boian Culture) (Mărgărit *et al*., 2014b), Isaccea (Boian Culture) (Micu, 2004; fig. 9) and Cheia (Hamangia Culture) (Voinea *et*. *al*., 2014).

At the technological level, the question asked at the beginning of the study was whether these procedures represented any kind of technological progress. In other words, was technological progress the reason why they were adopted or is a choice of technique more closely connected to local traditions of manufacture? Among the three main variants of longitudinal bipartition, the one using abrasion demands the greatest investment in time. At the end of the debitage operation two regular blanks are obtained. Their form and dimensions may be pre-visualized, but these observations are also relevant for the procedure of double grooving. Using this technological alternative less than half the amount of time is needed compared to the first manufacturing technique. Although in the Balkans area this second manufacturing procedure is known and used from the beginning of the Neolithic until the end of the Chalcolithic, it never became dominant. The situation becomes even more intriguing regarding the method of bipartition using indirect percussion. At first sight, even if the investment in time is reduced, this debitage procedure appears to be imprecise with a high risk of accidental fractures. Thus, this technique does not allow the artisan to control the block of material. Nevertheless, in the studied Chalcolithic assemblages, where the procedure is, by far, the most intensively used, the amount of debitage waste with accidental cracks (unusable blanks) is low, showing the technological ability and know-how of the people. It seems that this last technique represented a technical development because the same types of blanks as with the previous procedures can be obtained with less technological effort and with a minimal use of time. The only difference that can be invoked is at an aesthetic level because the flattened diaphysis in section are sometimes more visually appealing than the unmodified partial epiphyses.

The same observations are applicable for the segmentation with abrasive fibre. For bones from large sized animals the procedure was strictly used to eliminate the epiphysis and only the diaphysis was used. Therefore, a major investment in time was needed to obtain debitage waste when, during the Chalcolithic, the epiphyses are eliminated by direct percussion in a couple of seconds. In this case, it should be concluded that the use of these technological procedures represented a cultural choice or at least was not limited to a technological one, a factor that also determined their abandonment or sporadic use during the Neolithic and Chalcolitic.

CONCLUSION

The processing of osseous materials is strongly conditioned by their anatomical form which is why a limited range of transformational variables was expected, with minimal variations during prehistoric times. However, numerous specialists invoke the cultural value conferred by the community as the preeminent element in the selection of raw material, rather than the limitations of the raw material form (see *Introduction* section). This makes the study of these three types of 'manufacture-by-wear' technique all the more interesting. These techniques are not found in all prehistoric periods in the region. Thus, north of the Danube, the segmentation technique with abrasive fibre is known in Mesolithic communities in the Iron Gates area (it is attested at the settlements of Ostrovul Banului, Alibeg and Ostrovul Corbului) (Beldiman, 2005; Mărgărit & Boroneanț, 2017; Mărgărit *et al*., 2017, in press) but it is used strictly for the processing of the *Cervus elaphus* antler. At the beginning of Neolithic the antler pieces almost disappear but the technique continues to be used and applied now to bone. The other two techniques are not present in Mesolithic assemblages and they appear suddenly at the beginning of the Neolithic. The technique of bipartition by abrasion had clearly disappeared at the end of the Early Neolithic. Segmentation made with plant fibres is well represented during the developed Neolithic and even in some Chalcolithic cultures (e.g. Boian and Hamangia), and entirely disappears in the Late Chalcolithic (e.g. Gumelnița Culture). It cannot be said that there was any kind of progress or improvement of efficiency in the ways in which osseous materials were processed, because the manufacturing techniques used in the Chalcolithic produced the same results but were apparently simpler with a reduced investment in time.

The study demonstrates that the variety of the transformation schemes for hard animal materials is greater than expected and that some methods were invented or, maybe, adopted from neighbouring areas (in the form of objects or ideas) and used only at certain periods of time and subsequently abandoned. Moreover, it becomes quite clear that it is strictly a matter of technical choice which procedures were associated with certain typological categories (rings on blank in volume – segmentation with string from plant fibres; belt elements and rings made on flat blanks – the perforation-by-wear technique). Given the technological data discussed above, the osseous material industry can also act as a cultural marker in addition to ceramic style as long as we can identify clearly the time these objects ceased to be manufactured using these techniques and the object type abandoned, perhaps with the influx of new people or ideas, changing socio-economic imperatives or even cultural breakdown.

Experimental reconstructions support these conclusions despite the limits of the archaeological experiment (which requires caution in interpreting the data). They aimed at better understanding the way in which technological traces evolve during processing, and, implicitly, the patterns observed on archaeological artefacts. It is necessary to continue these experimental activities to gain further experience and to reduce the time required in the processing of an artefact.

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