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Cremated Human and Animal Remains of the Roman Period – Microscopic Method of Analysis (Šepkovčica, Croatia)

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ABSTRACT

Human and animal cremated osteological remains from twelve graves of Roman Period from archaeological site Šepkovčica near Velika Gorica (Turopolje region, NW Croatia) were analysed. Beside the content of urns and grave pits, fillings of grave vessels like bowls, pots and amphoras from twentytwo grave samples were included in this study. The preservation of osteological and dental remains of human and animal origin was very poor, majority of fragments hardly reach lengths of 10 mm. Weight of each specimen barely exceeds 100 g per person. Apart from traditional macroscopic methods of analysing cremated remains, microscopic method for determination of age at death was also tested. Fragments of femoral bone diaphysis of eighteen persons whose remains had been found on the site were analysed. Person's age at death was presented in the range of five or ten years, and the long bone fragments of a child (infants) were detected. Taxonomic position for each analysed specimen was determined by microscopic analysis of animal cremated bones. Analysis results confirm validity of microscopic method in determination of age at death for human remains and taxonomic qualification of cremated animal remains from archaeological sites.

Key words: *cremated bones, microscopic method, human remains, animal remains, Antique Period, NW Croatia*

Introduction

Archaeological site Šepkovčica is situated on the trace of the future highway Zagreb – Sisak (corridor A11), occupying 5 ha of the area near Velika Gorica, region Turopolje.

The most attractive findings from this site belong to the roman period, and those most numerous were grave items from the cemetery that includes 18 graves, 17 urn graves and a skeletal one. The numerous grave items place these graves in the time range of second half of the 1st to 2nd century, while the minority of graves was digged later, during the 4th century at the same area.

Analysis of cremated human and animal remains provide valuable information in several scientific areas: biological anthropology, archaeology, human and animal forensic medicine [1–4]. Estimation of sex, stature and age at death represent standard in analysis of cremated human remains. The beginning of bone microscopic research and detection of correlation within aging of a person and changes in the bone structure go back nearly entire century[5]. Kerley placed a fundament for all further researches on histological fragments of unburned long bones[6]. For the first time he connects number and condition of osteon system, as it is seen in hystological slide, with biological age of a person. Basic postulate of a method is that with aging of a person the number of osteon system in long bones will increase, while the percentage of a lamelar bone will decrease[6]. This method demonstrates higher deviations for samples of persons under twenty, so it can only be applied on long bone fragments of adults[7]. Several authors developed regression formulas for histological determination of age at death for long bone fragments[6,8], for ribs and clavicular bone[9] or developed relatively new method[9].

Till today several authors have contributed to the higher precision of the method by modifying it using the results obtained by an experimental, controlled heating

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on a human and animal samples of different anatomical elements[1,11–14]. Finding that the structure of a long bone burned at up to 800 °C does not change significantly helped in an application of the modified method by Kerley[15] for human burned bones. After detailed analysis on shrinkage of a bone during burning process at various temperatures the compact thickness (substantia compacta) of long bone proved to be an important factor in sex estimation of a person[16].

Yet, it is not possible to identify a precise age at death of an animal by using microscopic method, but it is possible to utilize it for taxomic identification of long bone fragments[17]. As with a human samples, it is of great importance to use animal samples that have not been burned at high temperatures which completely change the bone structure.

Material and methods

The cremated bones recovered from 17 urn graves were examined for identifiable bone fragments. Twelve of them were buried under the tumulus, while the other five were placed outside of the tumul´s rim. Complete filling of grave pits (100% specimen) was processed under flotation procedure and each specimen was marked. Several graves have specified numbers of samples due to complex marking of content from jars, dishes composition or pit fillings. According to grave and stratigraphic units signatures (for example f.e. grave 3, signature (sign.) SU-011), together with signatures that more precisely point to the placement of content (f.e. precise location inside the grave pit or filling of specific pot (sign. UZ,

TABLE 1
RESULTS OF MACROSCOPIC, MORPHOMETRIC AND MICROSCOPIC ANALYSIS OF SAMPLES

No	Grave, SU	Signature	Burned bone colour (Munsell designation)	SW (g)	WBS (g)	Sex	Age	Animal bones	Thickness of long bone fragments-diaphysis (mm)
1	1, SU 042	UZ-28,591	N9?5/0, N9, 10YR?7-8/1	44	37	M?	20–25	UB	3–4,5 (femoral bone)
2	1, SU 042	UZ-591	N6?5/0, 10YR?7-8/1, 2.5YR 7/3-4, 10YR 6/2	63	35	M?	20–25	UB	4,3–4,6 (femoral bone)
3	1, SU 042*	PN-26	2.5YR 7/3-4, 10YR 6/2	1	1	–	–	–	–
4	2, SU 027	UZ-3	10YR?7-8/1,2.5YR?7/3-4	66	3	M?	40–50	UB	4,4 (femoral bone)
5	3, SU 050	UZ-32	2,5Y?7/3-4, 2,5Y?6/3-4	19	19	M?	30–40	B,UB	3,7–4,7 (long bones)
6	3, SU 049	UZ-30	N9?5/0, N9, 10YR?7-8/1	20	20	F?	45–50	UB	2,7–3,9 (long bones)
7	3, SU 407	UZ-45	N4/0, N5/0, 10YR?7-8/1	65	65	F?	30–35	B,UB	2,9–4,0 (long bones)
8	3, SU 011	UZ-25	N 5,5/0, 10YR?7-8/1, N9/0	334	175	M?	40–45	B	4,5–4,5 (femoral bone)
9	4, SU 031	UZ-13	N5,5/0, 10YR?7-8/1	15	15	M?	30–40	UB	4,6 (femoral bone)
10	5, SU 017	U-17	10YR?7-8/1	30	4	M?	35–40	–	4,5 (femoral bone)
11	5, SU 017	PN-6	N5,5/0, 10YR?7-8/1, N9/0	82	82	M?	35–40		–
11	6, SU 425	UZ-52	N9/0, N9?5/0	76	66	F?	25–30	UB	4,5 (femoral bone)
12	7, SU 454	PN-228	2,5Y?7/3-4	48	45	F?	20–25	UB	3–3,1 (humeral and ulnar bone)
13	7, SU 454	PN-231	N9/0	3	3	F?	20–25	–	–
14	8, SU 462	UZ-66	10YR?7-8/1	23	23	F?	20–25	B	2,9 (humeral bone)
15	11, SU 477	PN-212	N7/0, N9?5/0	81	81	M,F	35–40M 30–35F	B	3,5 (humeral bone)
16	11, SU 477	PN-211	N7/0, N9?5/0	96	96	M,F	35–40M 30–35F	–	3,5 (humeral bone)
17	14, SU 1229	UZ-93	10YR?7-8/1	196	195	F?	20–25	B,UB	3,2 femoral bone
18	15, SU 1238	PN-311	N9/0, N9?5/0, N1, N4/0	44	44	F	30–35	B	3,0 (humeral bone) 3,7 (tibial bone)
19	16, SU 2006	PN-313	N9/0, N9?5/0	29	29	F?	25–30	–	3,0 (femoral bone) 3,1 (tibial bone)
20	18, SU 2029	PN-343	N5-6/0, N9/0, N9?5/0	312	312	M, infans	25–30, infans	–	4,3–4,5 (tibial bone), 3,5–4,5 (femoral bone)
21	18, SU 2029	PN-345-346	10YR?7-8/1, 2,5Y?7/3-4	19	19	M	25–30	B	–
22	18, SU 2029	PN-344*	N9/0, N9?5/0	16	16	–	25–30	B	–

SU – stratigraphic unit, SW – specimen weight, WBS – weight of a burned specimen, B – burned specimen, UB – unburned specimen, M – masculinum, F – femininum, * – animal bone specimen

PN) the analysis of osteological remains was carried out (Table 1).

After measuring weight of total specimen and each burned specimen separately, human samples were separated from animal ones for each grave. Sex and age at death for each person were estimated by macroscopic determination of human osteological remains. The results mostly depend on degree of preservation of samples[18,19]. Because of heavier fragmentation, besides determination of anatomical elements and estimation of sex for each grave sample it was not possible to determine age at death of a person more precisely. Macroscopic method for animal samples provides identification of anatomical elements and determination of species, genus or familia[20,21]. Temperature range for each grave specimen was determinated according to the specific colour expressed by Munsell designation[13] (Table 1). Estimation of age at death for a person was completed by modified microscopic method by Kerley for majority of graves by using regression formula. The basic principle is to count osteon system per surface unit and to detect its condition together with a percentage of lamellar bone. For the credibility of the method it is important to underline that specimens used for age estimation were not burned at high temperatures that completely change the bone structure.

All calcined samples, i.e. specimen burnt at high temperatures exceeding 900 °C must be excluded from a selection of the most suitable fragment of femoral diaphysis. Further selection of samples suitable for microscopic preparation includes measurement of long bone thickness. Femoral bone specimens were then sectioned on precision cut-off machine »Minitom« (Struers, Denmark) within the thickness range of 10–25 μm, and polished at Labopol-1 (Struers, Denmark) before fixing on a microscope slide. All microscopic slides are native. Light Microscopic analysis is performed under standard magnifications: 10×10, 20×10, 40×10 (Olympus, CX41RF). Photomicrographs were made by digital camera (Olympus 5050-Zoom). Totally, fiftyfour histological slides were prepared from human femoral bone fragments, or fragments of animal long bones from the samples.

Results

Beside a filling of grave pits (sign. UZ-591, 3, 32, 30, 25, 13, 17, 52, 66) or urns (sign. PN-19, 228, 211, 343), contents of various dishes (signature PN-313) representing grave items as bowls (sign. PN-26,345—346), cup (sign. PN-231), pot (sign. PN-212) and amphora (sign. PN-311) were analyzed (Table 1).

Weight of burned specimen rarely exceeds 100 g, exceptions are material from grave 3 (sign. SU-011,UZ-25) with weight of a burned specimen 175 g and from the grave 18 (18, SU 2029, PN 343) with a weight of a burned specimen 312 g. Preservation of specimens is very poor and it was possible to identify anatomical elements by macroscopic method on approximately 30% of examined material, and for only 15% it was possible to estimate nearly age at death. Fragments of burned long bones with length of less than 5 mm per sample present the majority of percentage. For majority of human specimens it was possible to estimate sex of a person. Exceptions were graves 7 and 8. Skeletons from these graves were most probably female persons.

Specimen undertones were recorded by Munsell classification (Table 1). It describes undertones of the analys specimen, from to the pure white colour. Temperature of bone burning varies from low 250–300 °C for some animal specimens (brown-black to black colour of bone), 400 °C (dark gray), 400–600 °C (light gray), 700–800 °C (light gray-white), 900 °C and higher (pure white colour, white with a light pink component). Majority of bone fragments shows characteristic »burning« deformations, it indicates that the body was still fleshed when placed on pyre. Macroscopic determination of sex for each person was carried out by using standard methods. Due to sample fragmentation it was possible to identify basic characteristics for some anatomical elements. Femoral bone fragments show a range of linea aspera expressions, from gently expressed (graves 15,16), medium (grave 18) to strong expressed (grave 11). Mostly, cranial bone elements are presented with occipital and temporal bone fragments with diplöe thickness as one of the major factors for sex estimation, together with robust pars petrosa (grave 3, SU-11,) or gracile temporal bone fragment (grave 15). Sex estimaton was also determinated by thickness of compact bone and total robusticity or gracility of preserved specimen for one grave. Estimation of sex with a certain assurance was possible for majority of human samples. Exception were human remains from graves seven and eight, these persons were most probably females.

Age determination by macroscopic method was successfully used for several grave samples, but even in those situations the range of years was too wide. Macroscopically, it was possible to notice partial or total disruption of certain cranial suture. Due to high fragmentation the results of this analysis were limited on determination of cranial suture openness-sutura lambdoidea at all positions (graves 3 sign. SU-11,11,18) as well as cranial suture openness of sutura occipitomastoidea (graves 1, 15, 18). Both sutures begin to close after the age of fifty. On a fragment of contact of left and right parietal bone from grave 18 it is clear that cranial suture on position S3-S4 (sutura saggitalis) was partially closed. It indicates age range under thirtyfive years at death. Microscopic method of age determination was carried out for each person and total number of prepared human hystological slides were fortyfour. Analysis includes testing condition of osteon system and its number per surface unit. Microscopic specimen of younger persons demostrate infrequent osteon systems, but with age osteons were more concentrate with more deformations. Due to poor preservation of bones found in graves 2 (sign. SU 027), 3 (sign. SU 050) and 4 (sign. SU 031) age was determined within ten year range, while for other remains found in other graves standard range of five years was presented (Table

1 and 2). Exceptionally, results of all analysed hystological slydes for one person show the same age estimation presented in two year range (grave 3 sign. UZ-30 age at death: 47 years, grave 3 sign. UZ-45 age at death: 30 years). Detail of photomicrograph of a femoral bone section of female person from grave 3 (sign. UZ-45) aged at death 30–35 shows high preserved concentric osteon systems (Figure 1).

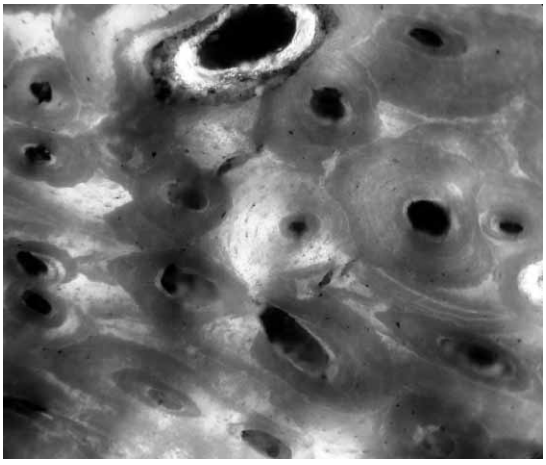

Fig. 1. Photomicrograph of a femoral bone section, female person (grave 3, sign. UZ-45) aged at death 30–35 years (femoral bone), (magnification 20×10).

Grave 3 is the most complex grave on the site with osteological remains of four persons. Males have the age range from 40–45 years (sign. UZ-25) and 30–40 years (sign. UZ 32) (Table 1 and 2). Age of female persons was in age range from 30–35 years (sign. UZ-45) and 45–50 years (sign. UZ-30) (Table 1 and 2). Determination in the age range of ten years testify for a low preservation of analysed osteological samples. All samples mentioned above originate from grave pits. It is importaint to note that inside the particular grave pit there was no mixing of person's remains within different stratigraphic units.

Urn content from the grave 11 (sign. PN 211) was analysed, and the most dominant was osteological material of a male person. Further metric analysis of bone fragments for the same sample helps with identification of another, female person's bone fragments for the same specimen. Analysis of pot filling from the same grave (grave 11, sign. PN 211) affirm existance of two persons in sample, this time the osteological material of a female person prevails. Microscopic method determinated age range for every person, from 35–40 years for male and 20–25 years for female person (Table 1 and 2).

Analysing osteological remains from urn filling (PN-343) from grave 18, beside the bone remains of adult male person two long bone fragments of a child (infans) were identified (Table 1 and 2). Examined fragments were small and significantly damaged. In hystological slide, regular system with only few osteon systems typical for very young persons can be seen (Figure 2).

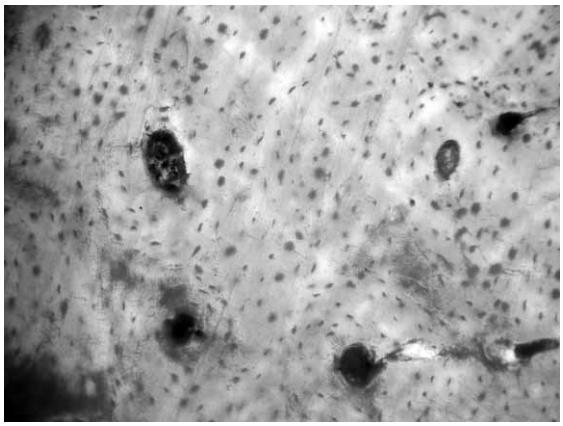

Fig. 2. Photomicrograph of a femoral bone section, child (infans) (18, sign. PN 343), (magnification 20×10).

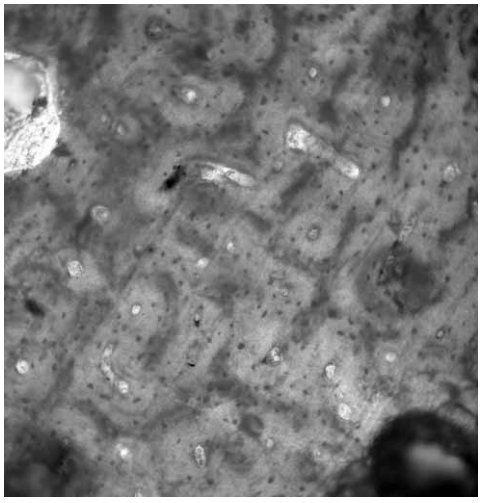

Fig. 3. Photomicrograph of a femoral bone section, small ruminants (sheep, goat, roe deer/ Ovis aries L., Capra hircus L., Capreolus capreolus L.), grave 3, sign. UZ 25, (magnification 20×10).

Macroscopic and microscopic methods of analysis determinated bone fragments of eighteen adult persons: one child (infans), nine women and eight men (Table 1.). Four persons for each age range from 20–25 (adultus I) and 30–35 years (adultus II). One person for each age range from 35–40 (adultus II), 40–45 (maturus I) and 45–50 years (maturus I) (Table 1 and 2). Three persons were in wider age range of ten years, two from 30–40 (adultus II) and one from 40–50 years (maturus I). Osteological remains of female persons were mostly represented in age range from 20–25 years (3 persons) and 30–35 years (3 persons), litlle less in the range from 25–30 years (2 persons), with the only one person in the age range from 45–50 years (Table 1 and 2). Men are the most numerous in age range from 30–40 years (4 persons), and two persons for each of the last age ranges presented, from 20–30 years and 40–50 years (Table 1 and 2).

Special attention was given to analysis of fillings from the pots or the grave pits, where the biggest abundance

TABLE 2
MICROSCOPIC DETERMINATION OF AGE AT DEATH – DESCRIPTION OF HISTOLOGICAL SAMPLES IN CORRELATION WITH AGE SPAN

Grave	Signature	Number of m. samples	Structural changes with age	Age at death (years)
18, SU 2029	PN-343	2H	Regular system, few osteon systems	infans
1, SU 042	UZ-28,591	3H	↓ Decrease of lamellar bone percentage? / Increase in number of osteon systems ↓ / Increase in number of deformations ↓	20–25
1, SU 042	UZ-591	2H		20–25
1, SU 042*	PN-26	1A		–
7, SU 454	PN-228	3H		20–25
7, SU 454	PN-231	–		20–25
8, SU 462	UZ-66	2H		20–25
14, SU 1229	UZ-93	2H,2A		20–25
6, SU 425	UZ-52	2H		25–30
16, SU 2006	PN-343	3H		25–30
18, SU 2029	PN-343	2H		25–30
18, SU 2029	PN-345-346	2H,2A		25–30
18, SU 2029	PN-344*	–		25–30
3, SU 407	UZ-45	4H,1A		30–35
11, SU 477	PN-212	2H		30–35
11, SU 477	PN-211	2H		30–35
15, SU 1238	PN-311	2H,1A		30–35
5, SU 017	U-17	2H		35–40
5, SU 017	PN-6	2H		35–40
11, SU 477	PN-212	1H		35–40
11, SU 477	PN-211	1H		35–40
3, SU 050	UZ-32	1H		30–40
4, SU 031	UZ-13	2H		30–40
3, SU 011	UZ-25	3A		40–45
3, SU 049	UZ-30	2H		45–50
2, SU 027	UZ-3	2H	Number of osteon systems will be quadrupled	40–50

H – human bone sample, A – animal bone sample

of animal remains was found (Table 3). Dimensions of these remains rarely exceed 10 mm, and macroscopic determination is somewhat difficult. Analysis of animal osteological content from twelve graves determinates presence of several animal species (Table 3). The most abundant were remains of a pig (*Sus sp*.), they were determinated in eight graves and ten units (Table 3). Small ruminant (*Ovis aries L., Capra hircus L., Capreolus capreolus L.*) fragments were found in six graves and eight units. Red deer osteological fragments (*Cervus elaphus L.*) were found only in one grave, but in four units. Big ruminants remains were present in one grave and three grave pits. Sporadic findings were those from cattle (*Bos sp*.) in one grave, and small fragments of bird bones (*Aves*) identified in two graves.

Microscopic preparations and analysis of animal long bones were made on ten hystological slides for fragments from graves 1, 3 (sign. SU-407), 14, 15 and 18 (Table 2). From results, specimen of small ruminants (sheep/goat), young and adult pig and cattle were determinated (Table 3).

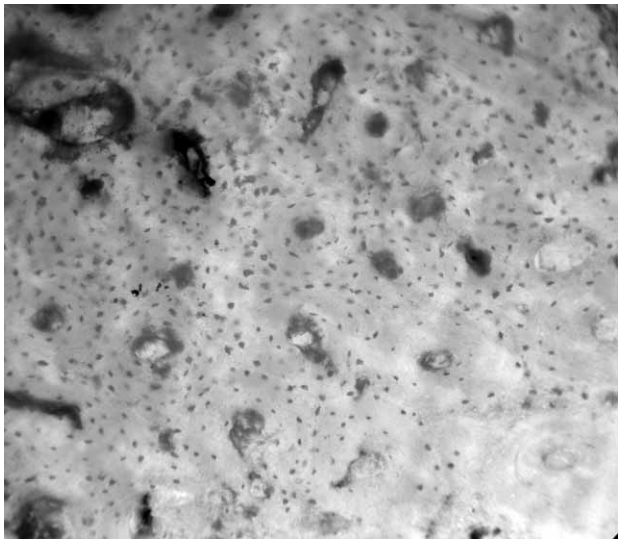

Fig. 4. Photomicrograph of a femoral bone section, cattle (Bos sp.), grave 3, sign. UZ 45, magnification (40×10).

TABLE 3
FRAGMENTS OF ANIMAL REMAINS AS PYRE OR GRAVE GOODS

Grave	Signature	Animal bones (B,UB)	Taxonomic determination
1, SU 042	UZ-28,591	UB	small ruminants (sheep, goat-Ovis aries L., Capra hircus L.), recent bird bones (Aves) and small rodents (Rodentia)
1, SU 042	UZ-591	UB	big ruminants (Ruminantia), young pig (Sus sp.), fish (Pisces)
1, SU 042*	PN-26	–	young pig (Sus sp.), fish (Pisces)
2, SU 027	UZ-3	UB	Red deer (Cervus elaphus L.), pig (Sus sp.), big ruminants (Ruminants), fish (Pisces)
3, SU 050	UZ-32	B,UB	small ruminants (sheep (goat/roe deer-Ovis aries L., Capra hircus L., Capreolus capreolus L.), red deer (Cervus elaphus L.)
3, SU 049	UZ-30	UB	red deer (Cervus elaphus L.)
3, SU 407	UZ-45	B,UB	odrasla svinja (Sus sp.), mali preživači (ovca, koza, srna-Ovis aries, L., Capra hircus, L., Capreolus capreolus L.), kokoš (Gallus gallus L.).
3, SU 011	UZ-25	B	small ruminants (sheep (goat/roe deer-Ovis aries, L., Capra hircus, L., Capreolus capreolus L.), cattle (Bos taurus L.), young red deer-Cervus elaphus L., pig (Sus sp.), hen(Gallus gallus L.)
4, SU 031	UZ-13	UB	pig (Sus sp.), small ruminants (sheep (goat/roe deer-Ovis aries, L., Capra hircus, L., Capreolus capreolus L.)
5, SU 017	U-17	–	–
5, SU 017	PN-6		small ruminants (sheep, goat-Ovis aries L., Capra hircus L.), big ruminants (Ruminantia)
6, SU 425	UZ-52	UB	pig (Sus sp.)
7, SU 454	PN-228	UB	pig (Sus sp.)
7, SU 454	PN-231	–	–
8, SU 462	UZ-66	B	birds (Aves)
11, SU 477	PN-212	B	pig (Sus sp.)
11, SU 477	PN-211	–	–
14, SU 1229	UZ-93	B,UB	pig (Sus sp.), fish (Pisces)
15, SU 1238	PN-311	B	small ruminants (sheep (goat/roe deer-Ovis aries, Capra hircus, Capreolus capreolus)
16, SU 2006	PN-343	–	–
18, SU 2029	PN-343	–	–
18, SU 2029	PN-345-346	B	small ruminants (sheep/goat/roe deer-Ovis aries, L., Capra hircus, L., Capreolus capreolus L.),
18, SU 2029	PN-344	B	pig (Sus sp.)

B- burned bones, UB-unburned bones

Long bone fragments from bowl filling of grave 1 (sign. PN 26) were microscopically examined. Hystological section detects characteristic layers of lamellar bone and bending of osteon system. This microscopic picture is characteristic for younger pigs (*Sus sp*.). Haversian canals are medium sized.

Long bone fragments as a content of a grave pit were analysed. Hystological section of specimens (grave 3, signature UZ-25) shows small system, combination of lamina and small concentric osteon system characteristical for small ruminants (Figure 3). Hystological sections of young individual demonstrate plexiform tissue layer which covers entire long bone section as in a sample from grave 3 (sign. UZ-32).

Hystological section of cattle long bone diaphysis is very simmilar to the human one, but Haversian cannal diameter is significantly smaller with pronounced concentric lamina of osteon system, as in the case of sample from grave 3, sign. UZ-45 (Figure 4).

Discusson

Specimen weight was very low and for majority of samples it did not exceed 50 g. For such samples macroscopic method cannot provide necessary information. For majority of human samples it was possible to estimate sex of a person, with exception of graves seven and eight. For these graves it was possible to claim that the persons were most probably females.

In grave eleven exist mixing of cremation fragments from urn and pot, and can be explained by archaeological findings. Obviously, in urn of grave eleven (sign. 211) a

male person was burried while in the pot of the same grave osteological remains of a female person were found. Both findings were partially destroyed, the pot was at first placed on the urn.

Osteological fragments of a child (infans) were identified in the urn filling of grave eighteen. Microscopic method determinated a wide age range including infans I and infans II age range (ending at age of fourteen). This method shows a greater deviations for infant specimen, and it is the main reason why it was not possible to determinate age of a child more precisely.

Available archaeological data affirm that the persons were cremated on a funeral pyre on the air without burying. Therefore the burning temperatures were determinated with a help of colour tables for burned bones on the air13. Darker colours and lower temperatures imply on the majority of animal osteological remains from the graves. Today it is known that from ending of cremation process to the collecting of bone and dental remains passes in average ten hours, although the real time will depend on weather and seasons during which the creamation is performed. As a result of notable difference in the colour of burned animal and human remains and very small proportion of totally burned animal bones, it is possible to presume that the animal meat were offered near the end of cremation process or even at the end of the ritual. This is the time when the temperature of pyre declines, or the rest is cooling, but even glow is still enough hot to leave marks on bones. Very small bone fragments white in colour are all calcinated. Unburned animal bone fragments could have been offered right before or at the moment of burial and they do not get in contact with a fire or pyre.

The majority of analysed human remains was burned at the temperature ranging from 600–800 °C. At these temperatures preservation of bone structure is almost unaffected. In several cases (graves 7, 6, 18, 11) colour of preserved epiphysal parts of massive bones indicates the activity of lower temperatures (400–500 °C). In above mentioned grave pits thin anatomical elements considerably lighter in colour were burned at the temperatures higher than 600 °C or 700 °C. Such case can reffer on cremation which did not last long enough to burn all elements evenly. There are more factors which affect cremation efficiency. Besides air presence, very importaint element is selection of fuel, precisely, type of firewood. For analysed specimen it was obvious that a high caloric wood type was used[11,14].

Recorded shrinkage of anatomical elements up to the temperatures of 800 °C or 900 °C is 5–25%[1,11,13.] The highest shrinkage percentage is noticed at higher temperatures. Ubelaker claim that no shrinkage occurs until the temperature reaches 700 °C, but between 700–900 °C some progression exists[22]. Advantage of applied method is in a fact that the long bone diaphysis despite higher temperatures has low percentage of shrinkage, especially if a small fragments of long bone diaphysis are sectioned for hystological slide[7]. On the temperatures higher than 900 °C bones are completely calcined, bone structure dissapears and it is impossible to perfom the analysis. Minor part of analysed specimen is snow white in colour and in hystological section it shows total mineralisation of bone with no visible bone structure.

Conclusion

Presented research has indicated how important results could be accomplished with combination of traditional macroscopic and microscopic mathods of analysis.

By using both methods of analysis, bone samples of eighteen persons and one child (infans, nine women and eight men were determined (Table 1). For female persons the most numerous age ranges are from 20–25 years (adultus I) and from 30–35 years (adultus II). Male persons are most numerous in age range of 30–40 years (adultus II).

Weight of a bigger part of analysed burned samples is very low and it does not exceed 100 g. By macroscopic methods it would be impossible to analyse samples completely. Development of microscopic methods provide significant improvments in human identification of burned and unburned small fragments of bones. Possibility for precise taxonomic identification of small animal fragments often found as a part of fill in bowls as a grave item or pyre item gives us new perception about customs of arcaheological populations. Applied method of osteon system analysis and their number per surface unit has already been confirmed as a more precise method than calculating share of osteonal bone in hystological section[23].

Further improvement of micoscopic methods for human and animal burned bones analysis will provide more information about paleodemographic image and funeral rituals of particular population, but also priceless data about a person itself, about an individual. In the last twenty years methods do extend on other anatomical elements of human skeleton and on study of microscopic characteristics of all animal long bones. Field of forensic osteology will largely benefit from these methods.

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REFERENCE

1. NELSON R, J Forensic Sci, 37 (1992) 1055. — 2. BASS WM, JANTZ R, J Forensic Sci, 49 (2004) 1. — 3. HOLLAND TD, J Forensic Sci, 34 (1989) 458. — 4. McKINLEY J, The analysis of cremated bone. In: COX M, MAYS S (Eds), Human Osteology In Archaeology and Forensic Science (Greenwich Medical Media, Cambridge, 2001). — 5. HEULER KM, Z Zellforsch Mikrosk Anat., 7 (1928) 54.— 6. KERLEY ER, Am J Phys Anthropol, 23 (1965) 149. — 7. WALLIN, JA, TKOCZ I, KRISTENSEN G, Int J Osteoarchaeol, 4 (1994) 353. — 8. KERLEY ER, UBELAKER DH, Am J Phys Anthropol, 49 (1978) 545. — 9. AHLQUIST J, DAMSTEN O, J Forensic Sci, 14 (1969) 205. — 10. STOUT SD, PAINE RR, Am J Phys Anthropol, 87 (1992) 111. — 11. BRADTMILLER B, BUIKISTRA JE, J Forensic Sci, 29 (1984) 535. — 12. STOUT SD, The use of cortical bone histology to estimate age at death. In: ISCAN MY (Ed), Age Markers in the Human Skeleton (Charles C. Thomas, Springfield IL, 1989).— 13. SHIPMAN P, FOSTER G, SCHOENINGER M, J Archaeol Sci, 11 (1984) 307.— 14. WALKER PL, MILLER KWP, RICHMAN R, Time, temperature, and oxygen availability: an experimental study of the effects of environmental conditions on the color and organic content of cremated bone. In: SCHMIDT CW (Ed), Burned Bone (Elsevier Press, Orlando FL, in press). — 15. LANGE M, SCHUTKOWSKI H, HUMMEL S, HERMANN B, Bibliography on Cremation (Council of Europe-PACT 19, Straßburg, 1987). — 16. HERMANN B, Behandlung von Leichenbrand. In: KNUSSMAN J, REINNER H (Eds), Antropologie-Handbuch der vergleichenden Biologie des Menchen, Band 1 (Teil Stuttgart/New York, 1988).— 17. HILLIER ML, BELL LS, J Forensic Sci, 52 (2007) 249. — 18. FEREMBACH D, SCHWIDETZKY L, STLOUKAL M, J Hum Evol, 9 (1980). — 19. ACSÁDI GY, NEMESKERI J, History of human life span and mortality (Akadémiai Kiadó, Budapest, 1970). — 20. GETTY R, Sisson and Grossman's the Anatomy of the Domestic Animals (WB Saunders Co, Philadelphia, 1975). — 21. NICKEL R, SCHUMMER A, SEIFERLE E, The Anatomy of Domestic Animals (Verlag Paul Parey, Berlin, 1986).— 22. UBELAKER DH, Human Skeletal Remains (Taraxacum, Washington, 1999).— 23. STOUT SD, The application of Hystological Techniques for Age at Death Determination. In: REICHS KJ (Ed), Forensic Osteology: Advances in the Identification of Human Remains (Charles C. Thomas, Springfield IL, 1988).

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SPALJENI OSTACI LJUDI I ŽIVOTINJA ANTIČKE STAROSTI – ANALIZA MIKROSKOPSKOM METODOM (ŠEPKOVČICA, HRVATSKA)

SAŽETAK

Analizirani su humani i životinjski spaljeni ostaci iz dvanaest grobova antičke starosti s arheološkog nalazišta Šepkovčica pokraj Velike Gorice (Turopolje, sjeverozapadna Hrvatska). Osim sadržaja žara i grobnih jama dvadeset i dvije grobne jedinice obuhvatile su ispune posuda u grobovima poput zdjela, lonca i amfore. Očuvanost koštanih i dentalnih ostataka humanog i animalnog podrijetla je vrlo nizak, riječ je o fragmentima čija dužina iznosi do 10 mm. Masa uzoraka rijetko prelazi 100 g po osobi. Uz tradicionalne makroskopske metode analiza spaljenih ostataka testirana je i mikroskopska metoda za odredbu starosti. Analizirani su fragmenti dijafize natkoljenične kosti za svih osamnaest osoba na nalazištu. Starosna dob osoba prikazana je u rasponu od deset ili pet godina, a utvrđeni su i koštani ostatci djeteta. Mikroskopska analiza spaljenih kostiju životinja utvrdila je taksonomsku pripadnost za svaki ispitani uzorak. Rezultati analize potvrđuju važnost mikroskopske metode u ispitivanju starosne dobi humanih i taksonomske pripadnosti životinjskih spaljenih ostataka arheološke starosti.