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SEARCHING FOR MACROFRACTURES CAUSED BY MODIFYING FLAKES INTO MOUSTERIAN POINTS

ABSTRACT

This article investigates impact fractures, fractures commonly referred to as DIFs (diagnostic impact fractures), that occur during the knapping process of Mousterian points in order to better understand and distinguish fractures caused by use versus those formed during knapping. A knapping experiment was conducted with an inexperienced and an experienced knapper, using decorticated cores of similar sizes and chert as the raw material. The study aimed to identify the types and causes of fractures caused by impact, compare fracture typology between knappers, explore the influence of knapper experience on fracture formation, and investigate to what extent macrofractures occur during the knapping process. The results show that the inexperienced knapper produced a higher percentage of fractures compared to the experienced knapper, with step-terminating fractures being the most common type in the inexperienced knapper's assemblage. Fractures on the proximal dorsal side were mainly caused by a bad striking angle, while fractures on the lateral side were attributed to flakes hitting the ground. On the experienced knapper's assemblage, the most common fractures were the impact notch and burin-like fractures. The experiment also identified diagnostic impact fractures and assessed their presence. The results proved that various fractures could be formed by the same causation, which further leads to the problem of equifinality. Overall, the research provides insights into fracture formation during knapping and highlights the importance of accurately interpreting lithic assemblages based on fracture characteristics.

KEYWORDS: STONE TOOLS, IMPACT FRACTURES, DIFs, MOUSTERIAN POINTS, MACROFRACTURES.

INTRODUCTION

When processing lithic material from Palaeolithic sites, such as waste flakes, blades, points, and scrapers, a significant number of impact fractures, including diagnostic ones (DIFs), can be identified (Goval 2016; Guardiola and Urbina 2022; Lazuén 2012; Lombard 2005; 2007; Moore *et al.* 2023; Rots 2009; 2013; Sano 2009; Yaroshovich 2013).

Pargeter's study (Pargeter 2011) on macrofractures is a significant contribution to the understanding of lithic material. Macrofractures, includ-

ing both diagnostic and non-diagnostic fractures, can provide insights into how stone tools were used. Pargeter's work discusses the importance of distinguishing between fractures caused by use and those generated during the manufacturing process.

Rots' research (Rots 2013) also delves into the formation of impact fractures in lithic material. The study may emphasise the potential for confusion between use-wear-related fractures and those created during knapping. Differentiating between these types of fractures is essential in order to draw accurate conclusions about tool function.

Lazuén's work (Lazuén 2012) could offer insights into the methods and criteria used to identify impact fractures, helping researchers distinguish between fractures resulting from use and those from other processes.

Lombard's studies (Lombard 2005; 2007) discuss the broader context of lithic analysis and its importance for understanding past human behaviour. The work addresses issues related to tool use and the formation of impact fractures.

While many of these fractures are created by impact, they do not necessarily indicate if the stone tool was used as a projectile or a hand-held weapon; they could have been formed during the knapping process itself. Understanding and distinguishing between impact fractures caused by use and those caused during knapping are crucial for accurately interpreting lithic assemblages and inferring past human behaviour.

THE RESEARCH AIMS OF THE KNAPPING EXPERIMENT

In order to gain an insight into the macrofracture propagation, the executed knapping experiment aimed to identify the types of DIFs that occur on stone tools and flakes during the knapping of Mousterian points. The experiment sought to compare the differences in fracture typology, quantity, and causes between an experienced and an inexperienced knapper. It also aimed to explore the influence of knapper experience on fracture formation, the correlation between impact fracture types and knapping variables, and the potential of identifying a knapper's experience based on impact fractures.

The key questions this experimental research aimed to answer are:

Which impact fractures, categorised as DIF (diagnostic impact fractures), can be identified as products of knapping incidents?

Which types of impact fractures, both diagnostic and non-diagnostic, can be attributed to a knapping incident?

Is it possible to infer the knapper's level of experience based on the characteristics of the impact fracture?

Is it possible to differentiate between the impact fractures caused by use, and those caused by knapping incidents?

MATERIALS AND METHODS

To ensure approximately controlled conditions, the knapping experiment utilised decorticated cores of similar sizes, and chert was used as the raw material. Both an inexperienced knapper (the author of this article) and an experienced knapper (Dr Marta Arzarello) knapped five Mousterian points each. The Mousterian points were made by retouching any suitable decorticated blanks (Bordes 1961: 804). The flakes were labelled and processed to identify the presence or absence of impact-like fractures, and after each strike, the flakes were analysed for damage to determine the cause of fracture formation. The inexperienced knapper worked with a core measuring 124 x 94 x 69 mm, while the experienced knapper utilised a core measuring 129 x 91 x 67 mm. In order to limit the variables, chert was the sole raw material employed in the experiment. Although the raw material plays a significant role in fracture formation, its influence is considered less important compared to use and taphonomy, as highlighted by Lombard (Lombard 2004) and Pargeter (Pargeter 2011; 2013). Both knappers used the same hard hammerstone, and the flakes were allowed to fall only onto a stone floor covered with plastic wrap. Each flake was carefully labelled and examined to determine the presence or absence of macrofractures and DIFs (Fisher 1984; Lombard, 2005; Pargeter 2011). To prevent any confusion or misinterpretation regarding the cause of damage formation, the flakes were analysed for damage after each strike. Any fracture identified as being caused by the impact was analysed using a low-magnification stereoscopic microscope (Leica LAS EZ) at 8x magnification, in addition to macroscopic analysis. Descriptive statistical methods were employed to interpret the identified damage.

RESULTS

The inexperienced knapper produced a total of 385 flakes during the knapping process of five Mousterian points. On the other hand, the experienced knapper generated 213 flakes while working on the same number of Mousterian points.

Fractures were present in 10.9% of the inexperienced knapper's assemblage (**Table 1**). The

Comparison Factor	Inexperienced knapper	Experienced knapper
Time	45 minutes	16 minutes
Flakes knapped	385	213
Fractures present	42 (10.9%)	19 (8.92%)
Predominant fracture area	proximal dorsal	lateral
Predominant fracture cause	bad striking angle	hitting the ground
Predominant fracture type	step-termination	impact notch/burin-like
Diagnostic impact fractures	8 (2.07%)	7 (3.28%)

Table 1. Results of experimental knapped assemblage.

Fracture type	Inexperienced knapper	Experienced knapper
Spin-off fracture > 6mm	4 (1.03%)	3 (1.4%)
Burin-like fracture	4 (1.03%)	4 (1.87%)
Bifacial spin-off	0	0

Table 2. Diagnostic impact fractures (DIFs) present in the knapped material.

Fracture Type	Frequency	Percent
Step-terminating bending fracture	13	31
Spin-offs > 6mm	4	9.5
Spin-offs	5	11.9
Impact notch	6	14.3
Crushing fracture	10	23.8
Burin-like	4	9.5
Total	42	100

Table 3. Macrofractures present in the inexperienced knapper's assemblage.

Fracture cause	Frequency	Percent
Retouching	13	31
Platform preparation	6	14.3
Hitting the ground	8	19
Poor striking angle	15	35.7
Total	42	100

Table 4. Fracture cause in the inexperienced knapper's assemblage.

Fracture type	Frequency	Percent
Step-terminating bending fracture	3	15.8
Spin-offs > 6mm	3	15.8
Spin-offs	2	10.5
Impact notch	4	21.1
Crushing fracture	3	15.8
Burin-like	4	21.1
Total	19	100

Table 5. Macrofractures present in the experienced knapper's assemblage.

Fracture cause	Frequency	Percent
Retouching	2	10.5
Platform preparation	3	14.3
Hitting the ground	9	47.4
Poor striking angle	5	26.3
Total	19	100

Table 6. Fracture cause in the experienced knapper's assemblage.

Fracture type	Frequency	Percent
No fractures	1	20
Crushing fracture	1	20
Step-terminating bending fracture	2	40
Spin-offs > 6mm	1	20
Total	5	100

Table 7. Fractures present on the Mousterian points - inexperienced knapper's assemblage

Fracture type	Frequency	Percent
No fractures	2	40
Spin-off	1	20
Crushing fracture	1	20
Spin-offs > 6mm	1	20
Total	5	100

Table 8. Fractures present on the Mousterian points - experienced knapper's assemblage

assemblage created by the inexperienced knapper exhibited a higher percentage of fracture presence compared to the experienced knapper's assemblage when knapping five Mousterian points (**Tables 1, 3, 4, 7 and 8**). Among the fractures observed in the inexperienced knapper's assemblage, the most common type was the step-terminating fracture, accounting for 31% (**Tables 1 and 3**). The majority of fractures formed on the proximal dorsal side of the flakes, amounting to 47.6% (**Table 1**). The variable that predominantly caused fractures was identified as a bad striking angle, responsible for 35.7% of the fractures (**Table 1**).

In the experienced knapper's assemblage, the most common fracture types were the impact notch and burin-like fractures, both occurring with a frequency of 21.1% (**Tables 1 and 5**). The lateral side of the flakes exhibited the highest occurrence of fractures, representing 52.6%. The primary cause of fracture formation was the flakes hitting the ground after being knapped from the core, accounting for 47.4% of the fractures (**Table 6**). Fractures were present in 8.92% of the experienced knapper's assemblage (**Table 1**). The identified diagnostic impact fractures (DIFs), such as spin-off fractures bigger than 6mm and burin-like fractures are presented in **Table 2**.

In the analysis of Mousterian points specifically, both knappers' assemblages exhibited a crushing fracture. Two points in the experienced knapper's assemblage did not have any formed fractures (**Table 8**), while one point knapped by the inexperienced knapper had no identified fractures (**Table 7**). Both knappers produced one ex-

ample each of spin-off fractures larger than 6 mm (**Tables 7 and 8**).

Visualisation of the data was employed to gain a better understanding of the variables. The figure (**Figure 1**) presents fracture areas and types for both knappers. It was observed that platform preparation contributed to fracture sizes ranging from 4-6 mm for the inexperienced knapper and 2-7 mm for the experienced knapper (**Figure 2**). For both knappers, the impact notch measured 2-5 mm. The step-terminating-bending fracture ranged from 1-10 mm for the inexperienced knapper and 6-10 mm for the experienced knapper. Spin-off fractures measured 2-11 mm in the experienced knapper's assemblage and 5-13 mm in the inexperienced knapper's assemblage (**Figure 3**). Impact notches occurred on flakes measuring 5-10 mm thick for the inexperienced knapper and 2-5 mm for the experienced knapper. Spin-off fractures with step-terminating-crushing fractures occurred on flakes measuring 5-18 mm for the inexperienced knapper and 10-19 mm for the experienced knapper. Step-terminating fractures occurred across a wide range of flake thicknesses in the inexperienced knapper's assemblage, spanning from 2 to 17 mm, while measuring 8-11 mm in the experienced knapper's assemblage (**Figure 4**).

A comparison of fracture causes and types is presented in **Figure 5**. Additionally, data regarding fracture area and cause is visually depicted in **Figure 6**. **Figures 7 and 8** showcase examples of fractures obtained from both knapping assemblages in this experimental research.

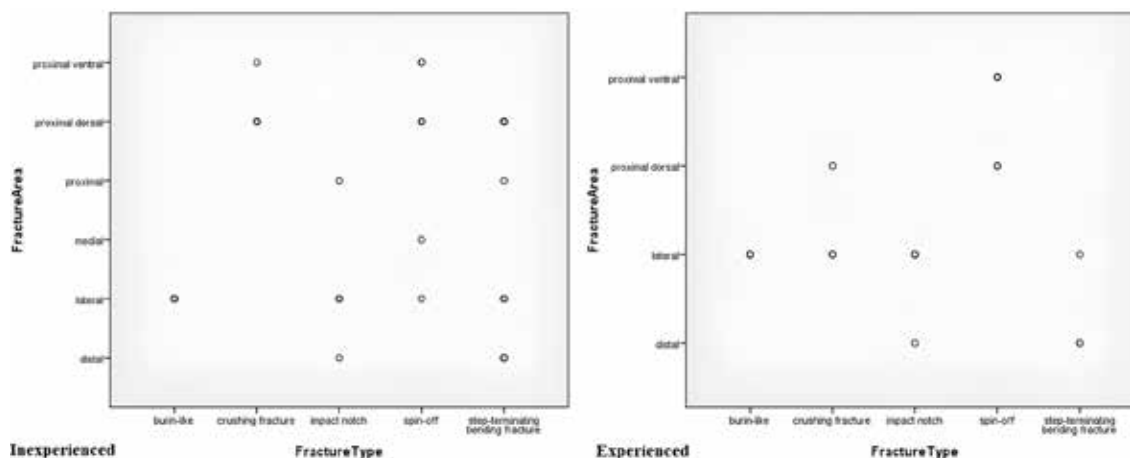


Figure 1. Comparison of the fracture area and fracture type (done using IBM SPSS Software).

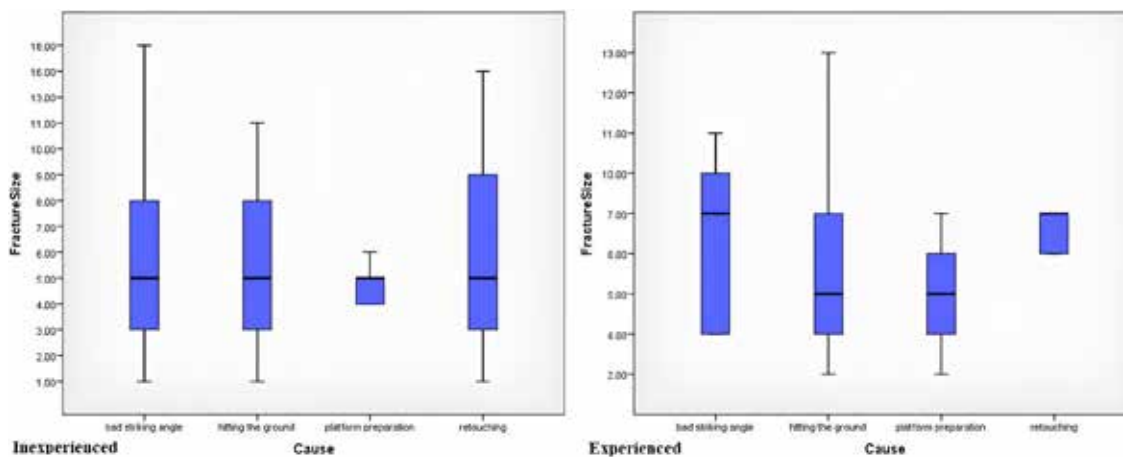


Figure 2. Comparison of the fracture size and fracture cause (done using IBM SPSS Software).

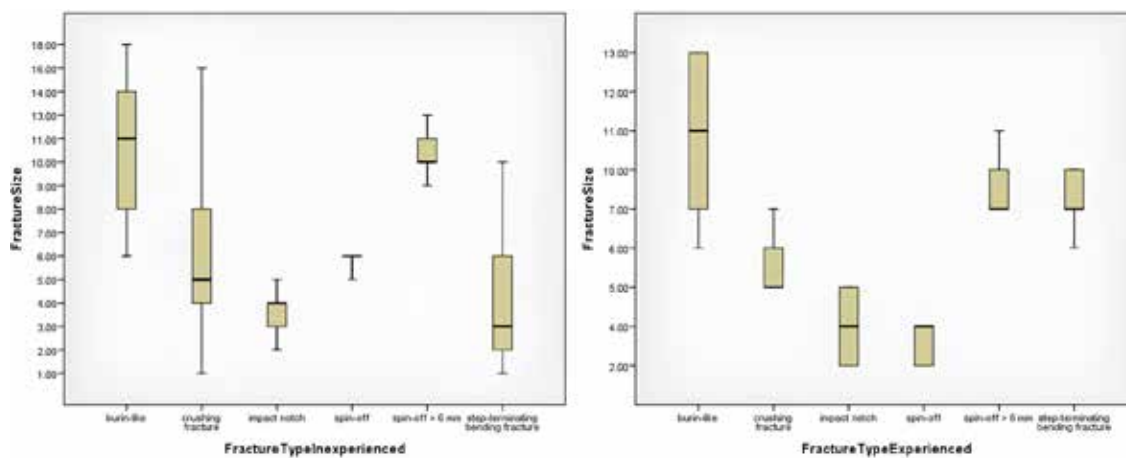


Figure 3. Comparison of the fracture size and fracture types (done using IBM SPSS Software).

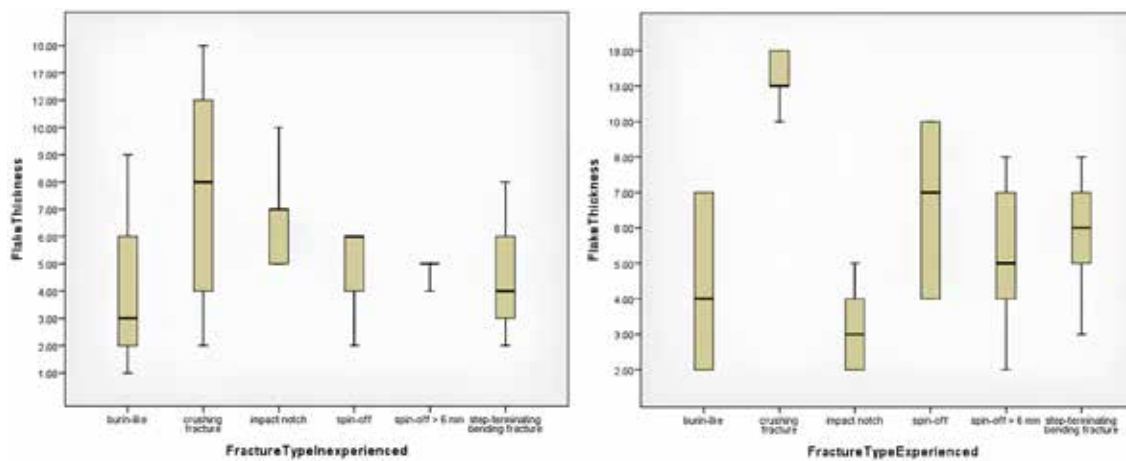


Figure 4. Comparison of the flake thickness and fracture (done using IBM SPSS Software).

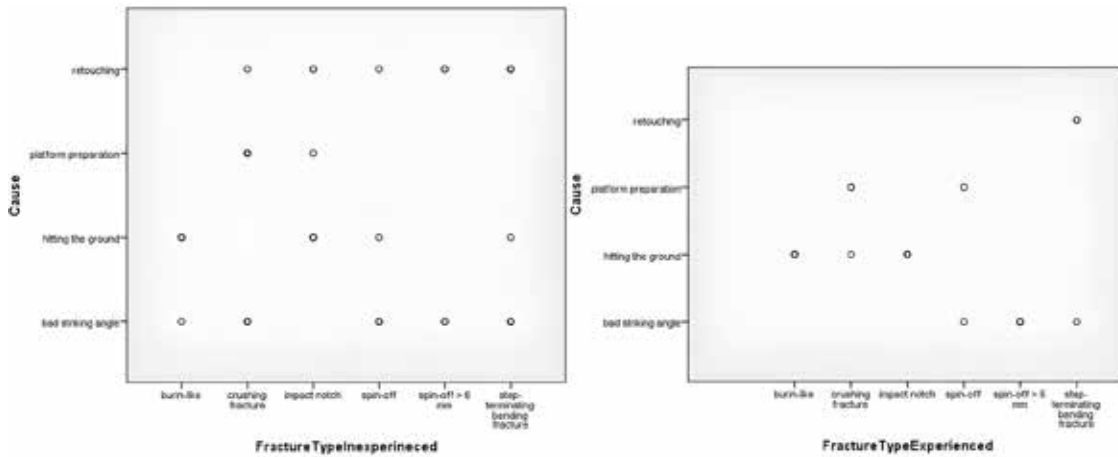


Figure 5. Comparison of the fracture type and fracture cause (done using IBM SPSS Software).

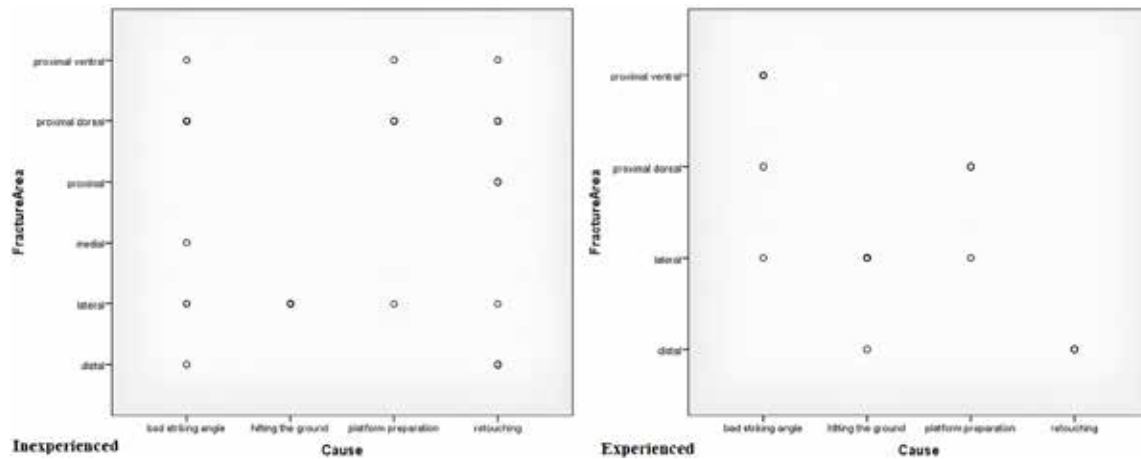


Figure 6. Comparison of the fracture cause and fracture area (done using IBM SPSS Software).

Fractures that resulted from a poor striking angle

The most prevalent fracture in the inexperienced knapper's assemblage was the step-terminating fracture, which was primarily caused by a bad striking angle (Table 1). In the experienced knapper's assemblage, crushing, burin-like fractures, and impact notches were not attributed to a bad striking angle. It is well established that the angle of the flake determines its size, rather than the striking force (Dibble and Rezek 2009: 1952). Due to the inexperienced knapper's limited ability to control the angle of each strike, there was significant variation in fracture types. On the other hand, the experienced knapper demonstrat-

ed much better control over the striking angle, resulting in the identification of only three fracture types: spin-off, spin-off larger than 6 mm, and step-terminating fractures.

Fracture causation due to accidental dropping or flakes hitting the ground

Fractures observed on the lateral and distal sides of the flakes were likely caused by impact with the ground, as no evidence of retouching, bad striking angle, or platform preparation was found. Both knapping assemblages exhibited the presence of burin-like fractures and impact notches, while spin-offs and step-terminating fractures were only identified once in each assem-



Figure 7. Damage identified in inexperienced knapper's assemblage: 1) Spin-off fracture > 6mm with step-termination caused by platform preparation; 2) Flake broken in half caused by a bad striking angle; 3) Spin-off fracture > 6 mm caused by platform preparation; 4) Crushing fracture caused by a bad striking angle; 5) Spin-off > 6 mm followed by step-terminating bending fracture caused by a bad striking angle while retouching; 6) Burin-like fracture caused by flake hitting the ground after being knapped (photo by the author).



Figure 8. Damage identified in experienced knapper's assemblage: 1) Crushing fracture caused by a bad striking angle; 2) Spin-off fracture caused by retouching; 3) Spin-off fracture > 6 mm caused by retouching (photo by the author).

blage. One instance of a crushing fracture was observed in the experienced knapper's assemblage. It is important to note that a direct comparison between these findings and the experiments conducted by Hutchings (2011) is not appropriate since Hutchings's experiment involved hafted stone tools used as spear-thrower darts, rather than being a dedicated knapping experiment. It should also be noted that the stone floor was not a common surface for the flakes to fall onto.

Retouching as a fracture cause

The application of retouching on the Mousterian points resulted in the occurrence of specific fractures. In the inexperienced knapper's assem-

blage, this retouching technique led to one crushing fracture, two step-terminating fractures, and one spin-off larger than 6 mm (**Figure 5**). Similarly, in the experienced knapper's assemblage, retouching caused the formation of one crushing fracture, one spin-off, and one spin-off larger than 6 mm (**Figure 5**).

DISCUSSION

In Pargeter's (2011: 2885) experiments, 4% of diagnostic impact fractures (DIFs) were identified in the knapped assemblage. In our experiment, we identified 2.07% DIFs in the inexperienced knapper's assemblage and 3.28% DIFs in the experienced knapper's assemblage. However,

it should be noted that step-terminating fractures were not considered DIFs in these results (Iovita *et al.* 2014: 8). If step-terminating fractures were included, the percentage of DIFs would be 5.45% in the inexperienced knapper's assemblage and 4.69% in the experienced knapper's assemblage.

As expected, the inexperienced knapper required more time to produce five Mousterian points compared to the experienced knapper. Additionally, the inexperienced knapper produced more waste flakes, resulting in a higher number of macrofractures. The ratio of knapped flakes to macrofractures was not expected to be similar for both knappers. The percentage of all macrofractures produced by the inexperienced knapper was 10.9%, while it was 8.92% for the experienced knapper (**Table 1**). This result implies that the level of experience does not directly influence macrofracture formation during the knapping process.

In the inexperienced knapper's assemblage, DIFs were predominantly present on the proximal dorsal side of the flakes, and the cause was attributed to a bad striking angle. In contrast, fractures were mainly observed on the lateral side of the flakes in the experienced knapper's assemblage, caused by the flakes hitting the ground after being knapped. This difference can be explained by variations in striking force and angle control. The experienced knapper had better control over the striking force and angle, resulting in impact-like fractures occurring when the knapped flake hits the ground, rather than experiencing step-terminating or crushing fractures on the proximal dorsal side, as observed in the inexperienced knapper's assemblage due to poor striking angles.

The results of this experiment shed light on which fractures can be considered a result of weapon use and which should be interpreted cautiously. Step-terminating bending fractures were once regarded as "the simplest" DIFs, formed due to longitudinal pressure from the distal and proximal ends of the stone tools (Fisher, 1984; Lombard, 2005: 115). However, Iovita and colleagues (2014: 8) challenged this claim through their experiments, arguing that the use of step-terminating bending-initiated longitudinal fractures as a diagnostic of impact is not entirely justified. According to their findings, these fractures occur as a result of a load distributed over a larger surface rather than concentrated at one point.

Equifinality poses a significant challenge in understanding the propagation of impact fractures. The same fracture type can occur due to trampling, knapping, hafting, or hunting damage (Fernandez-Marchena and Oll, 2016; Jayez and Nasab 2016; Knutsson *et al.* 2015; Ollé and Vergès 2014; Paixao *et al.* 2021; Pargeter, Shea and Utting 2016; Stemp, Watson, Evans 2016; Wilkins *et al.* 2012). Step-terminating fractures were identified in 3.37% of the inexperienced knapper's flakes and 4.69% of the experienced knapper's flakes. Based on these results and previous experiments, step-terminating fractures should be completely disregarded as DIFs (Iovita *et al.* 2014: 8; Pargeter 2013: 8).

Spin-off fractures, particularly those larger than 6 mm, have been considered reliable DIFs (Fischer, Hansen and Rasmussen 1984; Lombard 2005; Pargeter 2013; Pargeter, Shea and Utting 2016; Sano 2009). In our research, spin-off fractures larger than 6 mm were identified in 1.03% of the inexperienced knapper's assemblage and 1.4% of the experienced knapper's assemblage. Although spin-off fractures are less frequent than step-terminating fractures, the area of the fracture can help differentiate the cause (**Figure 1**). Fractures that are not caused by hunting are more likely to occur on the proximal parts of the stone tool (Villa *et al.* 2010; Thulman and Fenerty 2023), but the issue of hafting damage on the proximal sides of the stone tools leading to spin-off fractures remains a challenge (Rots, 2010; 2011; 2013; 2014). Burin-like fractures were identified on four flakes in both knappers' assemblages, accounting for 1.87% in the experienced knapper's assemblage and 1.03% in the inexperienced knapper's assemblage. This fracture type has been observed in previous knapping experiments, but it appears to be a reliable DIF only when another fracture is present on the same stone tool (Pargeter 2011; 2013). The results suggest that the only highly reliable DIF is the bifacial spin-off fracture, which was also noted in Pargeter's experiment (Pargeter 2011), and it was not identified in either knapping assemblage (**Table 2**).

CONCLUSION

In recent years, there has been growing interest in macrofractures, particularly those resulting from impact. With each experiment, we make

progress in understanding the propagation of impact fractures. However, fracture equifinality remains a significant challenge. Calculating the percentage of fracture types and their causation provides valuable information, but it is not sufficient to draw solid and definitive conclusions. To make progress in impact fracture analysis, we require a more extensive collection of experimental data. Step-terminating-bending fractures should be completely excluded from the DIF category as their formation could be the result of multiple causes, such as, hunting, trampling, knapping, etc (Iovita *et al.* 2014: 8; Partridge 2011: 2885). Furthermore, since step-terminating fractures are present in large numbers in almost all experimental assemblages, rather than ignoring them entirely, we should focus more on understanding the propagation of this fracture type, which should be the aim of future experiments. Additionally, even spin-off fractures larger than 6 mm, which were previously considered one of the most reliable DIFs, should be interpreted with caution in the future. Currently, the only highly reliable DIF is the bifacial spin-off fracture, as it was not identified in either knapping assemblage.

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REZIME

**TRAGANJE ZA MAKRO-
PRELOMIMA UZROKOVANIM
MODIFIKACIJOM KAMENIH
ODBITAKA U MUSTERIJANSKE
ŠILJKE**

KLJUČNE REČI: KAMENO ORUĐE, UDARNA OŠTEĆENJA, DIJAGNOSTIČNA UDARNA OŠTEĆENJA, MUSTERIJENSKI ŠILJCI, MAKRO-PRELOMI.

Ovaj eksperiment je za cilj imao ispitivanje preloma tj. oštećenja nastalih prilikom udara i dijagnostičkih tragova preloma na kamenim alatima kao posledice okresivanja musterijskih šiljaka.

U eksperimentu su učestvovala dva okresivača kamenih alatki, različitog stepena veštine okresivanja, sa ciljem da naprave po pet musterijskih šiljaka korišćenjem jezgara od roznaca sličnih dimenzija. Svaki odbitak je detaljno analiziran nakon svakog odbijanja od jezgra radi detektovanja oštećenja na alatima nastalih prilikom udara. Uzrok formiranja svakog oštećenja je dokumentovan. Takođe, detaljno su dokumentovani tipovi, veliči-

na i mesto oštećenja radi što detaljnije interpretacije rezultata.

Rezultati su pokazali da je neiskusni okresivač proizveo veći procenat oštećenja. Najviše zastupljeno oštećenje u materijalu neiskusnog okresivača su bile stepenaste terminacije koje su bile primarno prouzrokovane lošim uglom udara platforme. Sa druge strane, iskusni okresivač je imao bolju kontrolu nad udarom platforme i time proizveo drugačije tipove oštećenja koji su dominirali u njegovom materijalu. Uglavnom je reč o dletoolikim prelomima i nazubljenjima na lateralnim stranama odbitaka nastalih plikom odbijanja o tlo. Rezultati eksperimenta su takođe pokazali da se prilikom okresivanja kamenih alatki mogu formirati i neka od dijagnostičkih oštećenja (DIF).

U arheološkom materijalu prisustvo ovakvih preloma se može pogrešno interpretirati kao posledica korišćenja određenih kamenih alatki kao vrste oružja za lov. Takođe, ovaj eksperiment pokušava da odgovori na pitanje da li je prisutna razlika u oštećenjima nastalim prilikom udara, upoređivanjem alatki koje su napravili iskusni i neiskusni okresivači kamenih alatki u laboratoriji. Pokušano je uspostavljanje korelacije između svih varijabli koje mogu uticati na formiranje oštećenja nastalih kao posledica udara. Sveobuhvatno, ovaj eksperiment predstavlja jedan korak napred ka shvatanju formacije oštećenja nastalih prilikom udara tokom okresivanja musterijskih šiljaka i ukazuje na važnost opširnije analize i interpretacije litičkog materijala.

* * *

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BETTER TEETH, BETTER HEALTH? THE RELATIONSHIP BETWEEN ENAMEL HYPOPLASIA AND OSTEOLOGICAL STRESS MARKERS IN EBA POPULATION OF NORTHERN SERBIA

ABSTRACT

The Early and Middle Bronze Age Maros culture has been the subject of many archaeological studies aiming to answer questions related to social differentiation, status, and life histories. Archaeological and skeletal material from the necropolises of Mokrin and Ostojićevo has been employed numerous times to answer questions on status, diet, activity and kinship. Even though some things have become clearer, further information on the health status of these Bronze Age populations is needed for a deeper understanding of the social mechanisms and norms of the Maros culture. This paper examines the health status of a Bronze Age population from two archaeological sites, Mokrin and Ostojićevo, using osteological markers of stress and enamel hypoplasia. We hypothesise that individuals who experienced childhood stress, as evidenced by enamel hypoplasia, would exhibit greater vulnerability to infections and disease, as indicated by the presence and frequency of osteological stress markers. The analysis was conducted on a sample of skeletal remains, controlled for age-at-death, and assessed the correlation between enamel hypoplasia and cribra orbitalia, porotic hyperostosis, and periostosis. The findings indicate that reducing the health status to a single osteological stress marker is not a viable approach for this sample size. The analysis of consolidated variables, considering the presence and frequency of any osteological stress markers, yielded more promising results. The frequency of osteological markers showed a statistically significant positive correlation with both the presence and frequency of enamel hypoplasia; so we highlight the importance of considering multiple osteological markers of stress when assessing health status in the past populations.

KEYWORDS: ENAMEL HYPOPLASIA, OSTEOLOGICAL STRESS MARKERS, DOHaD HYPOTHESIS, HEALTH, EARLY BRONZE AGE, MAROS CULTURE.

INTRODUCTION: STRESS AND HEALTH

The term “stress” has gained significant prominence in contemporary medicine, and its usage has become ubiquitous in recent years. Although the concept was initially introduced by Hans Selye in the 1930s in the context of endocrinology (Selye 1936: 32; 1976), it has since evolved to encompass both physiological and psychological

aspects in popular discourse, and is commonly used in the field of bioarchaeology (Temple and Goodman 2014; Reitsema and McIlvaine 2014). While criticism of the usage of “stress indicators” in bioarchaeology because of their vagueness is valid (Temple and Goodman 2014; Edinburgh and Rando 2020), with proper contextualisation and specific research questions, they can still be very useful tools. Bioarchaeological stress markers include porotic hyperostosis, *cribra orbitalia*,

osteomyelitis, periostosis (Ortner 2003; Walker *et al.* 2009; Klaus 2017; Rivera and Mirazon Lahr 2017; Roberts 2019), skeletal growth (Armélagos *et al.* 1972; Cook 1984; Hoppa 1992) and dental enamel hypoplasia (Goodman and Rose 1990; Hillson 2014) among others. Their commonality lies in their disputed or unknown etiology, as they may not provide a definitive diagnosis, but rather serve as evidence of a physiological stress event experienced by the individual.

The question of the osteological paradox (Wood *et al.* 1992) has influenced both studies of stress indicators in physical anthropology and the analysis of the relationship between morbidity and mortality and the formation of stress indicators. The relationship between longevity and enamel defects has been at least somewhat confirmed in many studies (Armélagos *et al.* 2009; Amoroso, Garcia and Cardoso 2014), but researchers still urge caution because the strength of this correlation varies from context to context. Wood's theory drew attention to the still frequent typologically oriented works and directed future stress research to include as wide a range of factors as possible in their analyses (Klaus 2014; Reitsema and McIlvaine 2014; Temple and Goodman 2014). The field of physical anthropology has begun to integrate methods, theories and approaches of epidemiology (DeWitte 2014; Klaus 2014; Zuckerman 2014; Paskoff and Sattenspiel 2019), medical anthropology (Singer 2015), and evolutionary biology (Kinnally 2014; Amoroso and Garcia 2018) into stress studies in an attempt to move away from a typological and descriptive approach to research. D. Temple and J. Goodman, in their introduction to the special issue of the American Journal of Physical Anthropology devoted to the relationship between stress and health in physical anthropology, appeal to researchers to keep in mind that the relationship between indicators of stress and health is unclear and imperfect, and that its interpretation varies considerably depending on the context of the skeletons being investigated. In addition to careful contextualisation, their proposal is an evolutionary approach to investigating the plasticity of the human response to stress through research in both human biology and primatology (Temple and Goodman 2014: 190).

In contrast to bones, which undergo constant remodelling throughout an individual's life,

dental tissues remain unchanged once they are formed, barring external factors such as attrition or caries (Goodman and Rose 1990: 61-63; Hillson 2014: 32). This enduring quality makes teeth a reliable source of information on an individual's health and development during tooth formation, i.e., infancy and childhood. Anthropological analysis commonly utilises dentition to determine an individual's age, to infer indirect data on diet through examination of caries, attrition and calculus (Buikstra and Ubelaker 1994; White and Folkens 2012), to determine whether teeth were used as additional tools (Larsen 1995; Minozzi *et al.* 2003), and to evaluate childhood health by examining tooth enamel defects (Goodman and Armélagos 1988; Goodman 1993; Armélagos *et al.* 2009).

Two properties of dental enamel enable the inference of childhood health data from adults' teeth. Firstly, ameloblasts, the cells responsible for secreting the enamel matrix, are sensitive enough to cease secretion in response to physiological stress induced by illness or poor nutrition, without undergoing permanent damage. Consequently, when the stressor ceases, ameloblasts resume secretion, while the stress episode remains "recorded" in the enamel matrix in the form of a defect. Following the completion of enamel matrix secretion, ameloblasts undergo changes in shape and function and begin the process of enamel matrix calcification, during which the matrix loses proteins and water and becomes inert (Hillson 2014: 32). This inertness of the enamel is the second characteristic of teeth that allows the assessment of childhood health from adult teeth, as any defects in the enamel after calcification remain "sealed" as permanent markers of the stress episode (Goodman and Rose 1990; Hillson 2014).

In this paper we shall try to gain more understanding of the health status of a Bronze Age population from two archaeological sites - Mokrin and Ostojićevo - using osteological markers of stress. These two sites are important necropolises of the Early Bronze Age Maros culture which, owing to the abundance and variety of artifacts, wealth of information due to exceptional documentation and fairly good state of preservation, have been subjects of numerous studies on funerary rituals, social status, activity, kinship and life histories of people in Bronze Age Europe. Health and disease

are not just important for the understanding of the life history of an individual, they are inextricably connected with various cultural norms and both horizontal and vertical social status. In that vein, to have a holistic grasp of life in Bronze Age Maros communities we need to understand their health status as well. Our principal hypothesis is the *Developmental Origins of Health and Disease* framework (Barker 2004: 31), which posits that episodes of physiological stress survived in childhood lead to negative health outcomes in later life. We hypothesize that those individuals who have survived episodes of stress in their formative years, as evidenced by dental enamel hypoplasia, may exhibit greater vulnerability to infections and disease, as indicated by more frequent markers of osteological stress, such as porotic hyperostosis, *cribra orbitalia* and periostosis. Furthermore, we will explore whether there are significant differences in health status between men and women in this population.

MATERIALS

The Early and Middle Bronze Age Maros culture flourished in the Carpathian Basin, encompassing the territories of modern-day Hungary, Romania, and Serbia. Its borders are the rivers Koros in the north, Tisza in the west, and Zlatica and Galacka in the south (Bona 1975: 79; O'Shea 1996: 38). Most sites are grouped around the confluence of the rivers Maros and Tisza (Girić 1971: 231). The Maros culture was formed shortly after the disintegration of large cultural complexes of the Late Copper Age, and it is absolutely dated to a period between 2700 - 1700/1500 BC (Girić 1971; O'Shea 1992; O'Shea *et al.* 2019). Maros sites have been intensively researched and analysed, especially the necropoles, famous for various artifacts and an abundance of metal jewellery and weapons, with multiple sites being subjects of fieldwork in the last decade.

The Mokrin necropolis is situated in the northern Banat region of Serbia (**Figure 1**), in close proximity to the city of Kikinda (Girić 1971: 9). To date, a total of 319 graves have been uncovered, with an estimated 50-100 graves remaining undisturbed (Girić 1971: 34). Initial excavation campaigns were carried out in the 1950s and 1960s, which uncovered most of the graves,

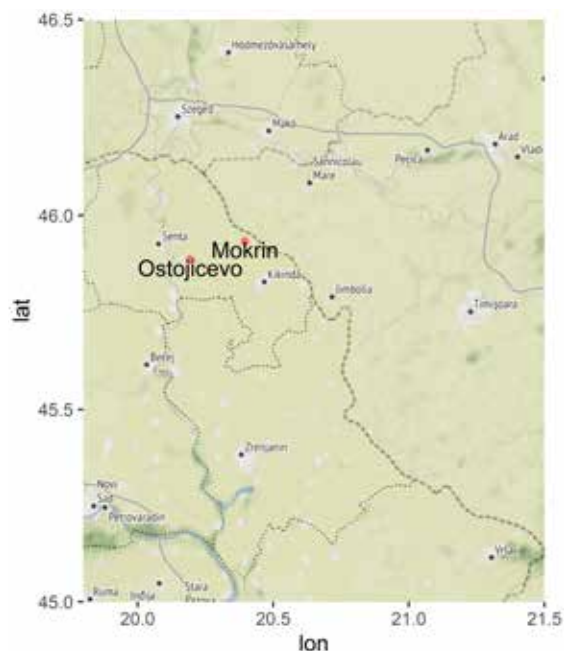


Figure 1. Map of the Banat region with the Mokrin and Ostojićevo necropolises (done using R project software: R Core Team 2022, ggplot 2 package: Wickham 2016).

while a new excavation campaign started in 2020 and is still ongoing (Pendić *et al.* 2022). Most of the deceased were buried in individual graves, in a crouched position on their side, oriented north-south or south-north, facing towards the east. Grave goods included ceramic vessels, copper and bronze daggers and axes, as well as various types of jewellery made from copper, bronze, gold, sea-shells, animal teeth, kaolin beads and, in one case, even a human rib (Girić 1971; Stefanović 2006; Ljuština, Krečković and Radišić 2019). The necropolis has been absolutely dated to 2100 - 1800 BC (O'Shea 1992), although recent excavation campaigns have provided evidence of later use of the site, probably dating to the Early Middle Ages¹. The Mokrin necropolis has been the subject of numerous studies, both archaeological (Girić 1971; O'Shea 1996; Stojanović *et al.* 2020; Pendić *et al.* 2022) and bioarchaeological (Porčić and Stefanović 2009; Stefanović 2008; Stefanović and Porčić 2013; Žegarac *et al.* 2021; Blagojević 2020; Vitezić 2017; Krečković Gavrilović 2022).

¹ Results of the new excavation campaign of the Mokrin necropolis are still not published, but the author of this paper has been a part of the excavation team, so she has a first-hand account of the new found graves.

The Ostojićevo necropolis is situated in the northern Banat region of Serbia (**Figure 1**), in the vicinity of the city of Kikinda. The site is located on the edge of the village of Ostojićevo, on the shore of a now dry meander of the Tisza river (Milašinović 2008: 38). The site was excavated in the 1990s and, unlike Mokrin, it is a multi-layered site. A total of 77 graves belonging to Maros culture come from the oldest layer, while the remaining 208 have been dated to the Middle Bronze Age (Milašinović 2008: 39; O'Shea *et al.* 2019: 617–618), with a clearly demarcated hiatus period between the two. The necropolis has been absolutely dated from c. 2000 BC for the Maros graves, with the hiatus beginning at around 1800 BC, while the necropolis was again put to use around 1600 BC (O'Shea *et al.* 2019: 604–623). Unlike Mokrin, archaeological material from Ostojićevo has not been published in its entirety as of yet, although it has been analysed. L. Milašinović (2008) analysed the grave goods for her unpublished Master's thesis, D. Vučetić (2015) examined markers of occupational stress of the Ostojićevo population, and T. Blagojević (2020) published some of the archaeozoological material from the Ostojićevo graves.

METHODS

The aim of this study is to investigate the proposed hypothesis regarding the potential correlation between episodes of physiological stress experienced during childhood and subsequent health outcomes. To achieve this, we will utilize two types of osteological markers of stress, namely dental enamel hypoplasia to assess episodes of childhood stress and *cribra orbitalia*, porotic hyperostosis and periostosis to determine the individual's health status in later life. Although the paleopathological analysis of the skeletal material was more extensive, due to poor preservation of the osteological material, only these three markers were recorded in adequate quantities for statistical analysis.

For this paper, dental enamel hypoplasia was analysed macroscopically and, when necessary, with a hand-held magnifying lens. Given the considerable sample size, which exceeded the feasible capacity for scanning electron microscopy (SEM) analysis within a reasonable time and cost con-

straints, a macroscopic approach was deemed more practical. We established a specific protocol for the recording of enamel hypoplasia that included observation of tooth presence/absence, presence/absence of hypoplastic defects of enamel, quantification of the total number of defects, measurement of the total height of tooth crown, and determination of the height at which the defects were detected. Teeth were observed under two light sources - natural light and a table top lamp, set up in such a way that light refraction made defects easier to observe on a highly reflective enamel surface. In addition, teeth were cleaned of sediment and glue with the use of brushes, dental probes and an acetone solution as needed.

To calculate when the episode of stress that resulted in a defect occurred, i.e., the age of the individual when enamel hypoplasia formed, we used the height of the crown and height at which the defects were detected. We utilized previously published tooth crown growth schedules to calculate the age-at-formation of the defects (**Table 1**); for incisors, canines and molars we used formation schedules established by D. Reid and M. Dean (2006: 343–344) and for premolars those created by S. Holt and colleagues (Holt, Reid and Guatelli-Steinberg 2012: 6).

Osteological markers of stress were recorded in accordance with standards of physical anthropology (Mann and Hunt 2013; Ortner 2003; Roberts 2019). They were marked as present, absent or bone missing.

Of 312 graves from the old excavations of the Mokrin necropolis, for this paper we have sampled the skeletal remains of 92 individuals. We have only included the remains of adult individuals with appropriate levels of preservation of cranial, postcranial and dental material. The state of preservation of the osseous material is poor to medium due to taphonomic processes, mainly the high acidity of the sediment in which the deceased were interred, as well as the amount of previous handling and analyses of the material.

The state of preservation of the skeletal material from the Ostojićevo necropolis is considerably better, albeit the number of Maros graves available for analysis is comparatively modest. We included the skeletal remains of 36 adult individuals from the 77 Maros graves excavated at Ostojićevo for our investigation.

Decile of crown length *	UI1	UI2	UC	LI1	LI2	LC
1 st	1.1-1.3	1.8 - 2.0	1.7 - 1.9	0.8/1.0 - 1.0/1.1	1.0 - 1.1/1.2	1.4/1.5 - 1.6/1.7
2 nd	1.3 - 1.5/1.6	2.0 - 2.2	1.9 - 2.1/2.2	1.0/1.1 - 1.1/1.3	1.1/1.2 - 1.3	1.6/1.7 - 1.9/2.0
3 rd	1.5/1.6 - 1.7/1.8	2.2 - 2.4	2.1/2.2 - 2.3/2.4	1.1/1.3 - 1.3/1.5	1.3 - 1.5	1.9/2.0 - 2.1/2.3
4 th	1.7/1.8 - 1.9/2.0	2.4 - 2.6/2.7	2.3/2.4 - 2.5/2.7	1.3/1.5 - 1.5/1.7	1.5 - 1.7/1.8	2.1/2.3 - 2.4/2.7
5 th	1.9/2.0 - 2.2/2.4	2.6/2.7 - 2.9	2.5/2.7 - 2.8/3.0	1.5/1.7 - 1.7/2.0	1.7/1.8 - 1.9/2.1	2.4/2.7 - 2.8/3.1
6 th	2.2/2.4 - 2.5/2.9	2.9 - 3.2/3.3	2.8/3.0 - 3.1/3.4	1.7/2.0 - 2.0/2.3	1.9/2.1 - 2.2/2.4	2.8/3.1 - 3.2/3.6
7 th	2.5/2.9 - 2.9/3.4	3.2/3.3 - 3.5/3.7	3.1/3.4 - 3.5/3.8	2.0/2.3 - 2.3/2.6	2.2/2.4 - 2.6/2.8	3.2/3.6 - 3.7/4.2
8 th	2.9/3.4 - 3.4/3.9	3.5/3.7 - 3.9/4.1	3.5/3.8 - 4.0/4.3	2.3/2.6 - 2.7/3.0	2.6/2.8 - 3.0/3.3	3.7/4.2 - 4.2/4.9
9 th	3.4/3.9 - 3.8/4.4	3.9/4.1 - 4.4/4.6	4.0/4.3 - 4.4/4.8	2.7/3.0 - 3.1/3.4	3.0/3.3 - 3.4/3.7	4.2/4.9 - 4.7/5.6
10 th	3.8/4.4 - 4.2/5.0	4.4/4.6 - 4.8/5.3	4.4/4.8 - 4.8/5.3	3.1/3.4 - 3.4/3.8	3.4/3.7 - 3.8/4.2	4.7/5.6 - 5.2/6.2

Table 1. Mean estimated chronological age of enamel formation in anterior teeth for each decile of crown length for anterior teeth. Estimates are given for both southern African and north American samples according to Reid and Dean (2006: fig.3). *Deciles of crown length are numbered from apical (1st decile) to CEJ (10th decile)

In addition to the data concerning osteological markers of stress, we collected data on sex and age of the individuals, according to current standards in physical anthropology (Buikstra and Ubelaker 1994; White and Folkens 2012). All the statistical analyses for this paper were done in IBM SPSS Statistics 23 software.

RESULTS

Preservation of the dentition of the individuals buried at Mokrin and Ostojićevo

As was previously mentioned, the state of preservation of the osseous material from Mokrin and Ostojićevo is suboptimal. Although dental remains tend to have better preservation, numerous individ-

uals were excluded from the sample due to having only a limited number of teeth or none at all. In this study, we define preservation as the presence of at least one tooth of each type in a tooth row, regardless of its lateralisation. In other words, mandibular dentition is considered to be 100% preserved when one central incisor, one lateral incisor, one canine, one first premolar, one second premolar, and one first, second, and third molar are present, irrespective of their location within the left or right mandible. As tooth enamel formation is not dependent on lateralisation, but on tooth type (Hillson 2014: 33), having at least one tooth from each pair of the same type is sufficient for unhindered tracking of the tooth formation sequence. Approximately 60% of individuals in our sample had more than a half of their dentition preserved (see **Table 2**).

	<25%	25-49%	50-74%	>75%
Mokrin	12 (13%)	27 (29.3%)	36 (39.1%)	17 (18.5%)
Ostojićevo	3 (9.4%)	8 (25%)	14 (43.8%)	7 (21.9%)
total	15 (12.1%)	35 (28.2%)	50 (40.3%)	24 (19.4%)

Table 2. Preservation of dentition for the sample from Mokrin and Ostojićevo (adapted from Krečković Gavrilović 2022: 68, fig. 5.1).

In this study we employed two variables to monitor the osteological markers of stress: their presence and their frequency. We observed three markers of stress for each individual: *cribra orbitalia*, porotic hyperostosis and periostosis. To mark osteological markers of stress as present, the presence of any of the aforementioned markers was enough; to mark it as absent, the skeleton of the individual had to be preserved enough so we could safely say the absence of the marker was not due to poor preservation. The frequency of osteological markers of stress variable follows the same logic regarding the absence of the markers, and uses values 1-3 depending how many of the three markers were found on the skeleton. All skeletons that were not preserved enough were excluded from the analysis.

To maximize the sample size for the analysis, the individuals were separated into three broad age categories: the youngest adults in the sample (18-35), middle-aged group (35-50), and the oldest individuals in the sample (50+). However, due to the poor preservation of the skeletal material, the age ranges for most individuals were very broad, rendering this classification rudimentary and imperfect.

Following the logic of the osteological paradox approach, older individuals, having lived longer lives, could have had more opportunities to develop markers of stress on their skeletons (Wood *et al.* 1992: 352). To establish if there is a relationship between the presence of osteological markers of stress and age at death, we conducted a correlation test using Kendall's tau coefficient. Our findings revealed a weak positive correlation between the presence of osteological markers of stress and the age at death. However, this correlation was not statistically significant (Kendall's tau=0.33; p=0.123; N=87). Additionally, a correlation test using Kendall's tau coefficient showed a very weak positive correlation between

the frequency of osteological markers of stress and the age at death. Nevertheless, this correlation was also not statistically significant (Kendall's tau= 0.117; p=0.295; N=68). As our results indicated that age at death was not associated with either the presence or frequency of the observed osteological stress markers, we proceeded to examine the correlation between these markers and enamel hypoplasia.

Childhood stress and the presence of *cribra orbitalia*

To ascertain if there is a relationship between an episode of physiological stress survived in childhood signalled by enamel hypoplasia and formation of *cribra orbitalia*, we conducted a correlation test using Kendall's tau coefficient (**Figure 2**). The results showed that there is a very weak positive correlation between the presence of *cribra orbitalia* and enamel hypoplasia that is not statistically significant (Kendall's tau=0.078; p=.434; N=101). The same was true for the sample divided by sex, as both men (Kendall's tau=0.124; p=.375; N=45) and women (Kendall's tau=0.006; p=.967; N=49) demonstrated a similarly weak positive correlation that was not statistically significant.

By utilizing the tables of estimated timing of enamel formation (Reid and Dean 2006; Holt, Reid and Guatelli-Steinberg 2012), it is possible to infer the number of physiological stress events experienced by an individual during childhood while their teeth were developing. Enamel formation timelines were used to divide the developmental period into five distinct phases for the purposes of this paper, namely: 0.8-2.4 years, 2.5-3.4 years, 3.5-4.4 years, 4.5-5.4 years, and 5.5-6.4 years. These phases were employed to ascertain the frequency of childhood stress episodes that an individual may have experienced and survived.

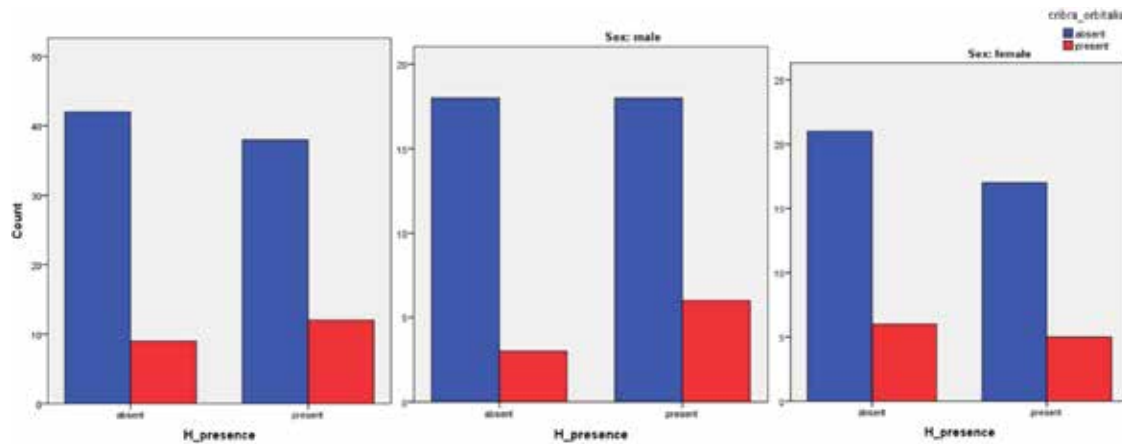


Figure 2. The presence of *cribra orbitalia* compared to the presence of enamel hypoplasia. Bar graphs to the left represent the whole sample, the middle ones are for the male and the far right are for the female sample (done using IBM SPSS Software).

Despite the lack of a statistically significant correlation between the presence of enamel hypoplasia and *cribra orbitalia*, an investigation was conducted to examine the potential correlation between the frequency of stress episodes indicated by enamel hypoplasia and the frequency of *cribra orbitalia*, utilizing Kendall's tau coefficient (**Figure 2**). The analysis was conducted on the entire sample and yielded a very weak positive correlation that was not statistically significant (Kendall's tau=0.076; $p=.424$; $N=102$). A similar outcome was observed for the male sample, which showed a weak positive correlation that was not statistically significant (Kendall's tau=0.132; $p=.357$; $N=45$). On the other hand, the female sample displayed a very weak negative correlation, which was also not statistically significant (Kendall's tau=-0.007; $p=.959$; $N=50$).

Childhood stress and porotic hyperostosis

In our analysis of the Mokrin and Ostojićevo samples, we noted a considerably lower incidence of porotic hyperostosis relative to *cribra orbitalia*. We again tested the correlation between the presence of enamel hypoplasia and porotic hyperostosis using Kendall's tau coefficient (**Figure 3**). The results showed a statistically significant positive correlation between the two variables (Kendall's tau= 0.258; $p=.007$; $N=112$). When we separated the sample by sex, a very weak positive correlation was observed for the male sample, which was not statistically significant (Kendall's tau=0.231;

$p=.110$; $N=49$). Conversely, a statistically significant positive correlation was detected for the female sample, with a Kendall's tau coefficient of 0.307 and a p -value of .024, based on a sample of 55 individuals.

In addition, we tested the correlation between the presence of porotic hyperostosis and the frequency of enamel hypoplasia using Kendall's tau coefficient (**Figure 3**). The results revealed a statistically significant weak positive correlation for the entire sample (Kendall's tau=0.215; $p=.017$; $N=113$). When we separated the sample by sex, a statistically significant weak positive correlation was found for the male sample (Kendall's tau=0.296; $p=.031$; $N=49$), whereas for the female sample a weak positive correlation was observed, which was not statistically significant (Kendall's tau=0.185; $p=.149$; $N=56$).

Childhood stress and periostosis

Due to the subpar preservation of the skeletal material, the sample size for periostosis was the smallest one. Our analysis using Kendall's tau coefficient (**Figure 4**) revealed a very weak positive correlation between the presence of periostosis and enamel hypoplasia that was not statistically significant (Kendall's tau=0.047; $p=.667$; $N=86$). For the male sample we found a weak negative correlation between periostosis and enamel hypoplasia that was not statistically significant (Kendall's tau=-0.108; $p=.506$; $N=39$). Conversely, for the female sample, the correlation test showed a

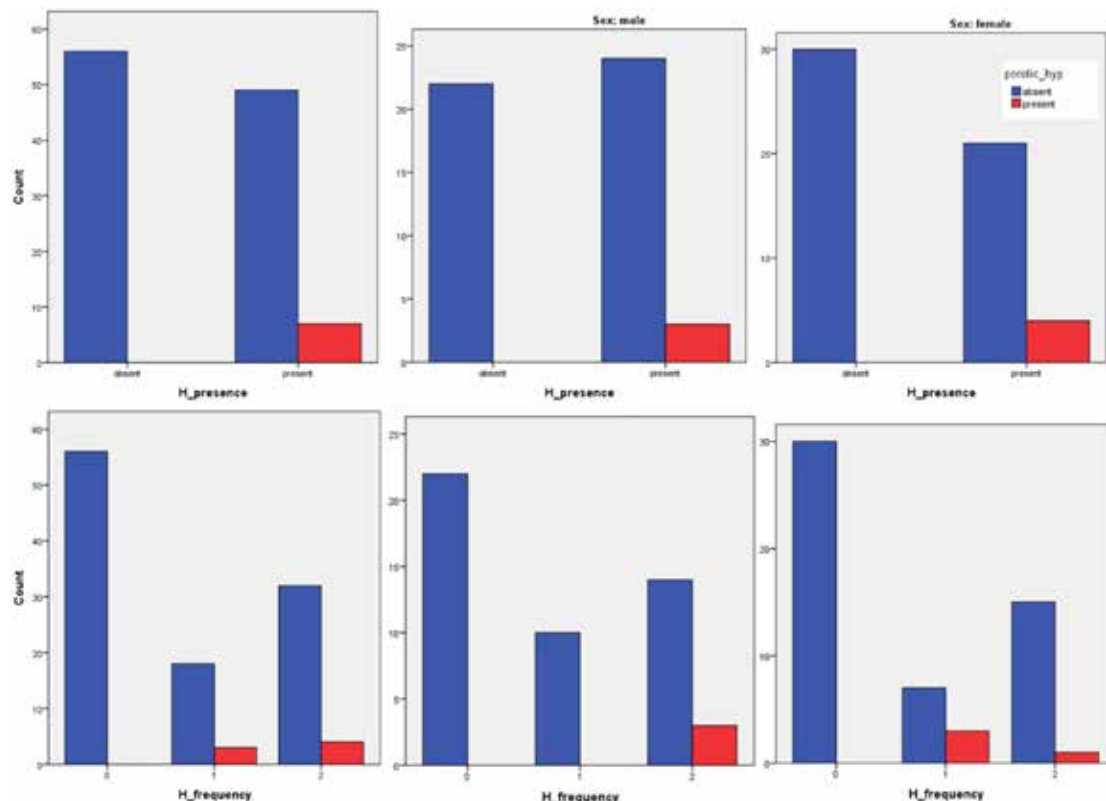


Figure 3. The presence of porotic hyperostosis compared to the presence (upper row) and frequency of enamel hypoplasia. Bar graphs to the left represent the whole sample, the middle ones are for the male and the far right are for the female sample (done using IBM SPSS Software).

weak positive correlation between the presence of periostosis and enamel hypoplasia that was not statistically significant (Kendall's tau=0.100; $p=.528$; $N=41$).

We further examined the association between periostosis and enamel hypoplasia frequency using Kendall's tau correlation coefficient (**Figure 4**). Our analysis revealed no statistically significant correlation between the two variables (Kendall's tau = 0.0001, $p = .988$, $N = 87$). When we divided the sample by sex, the male sample displayed a weak negative correlation between periostosis and the frequency of enamel hypoplasia, which was not statistically significant (Kendall's tau=-0.119; $p=.440$; $N=39$). On the other hand, for the female sample no statistically significant correlation was observed (Kendall's tau=0.000; $p=1.000$; $N=42$).

Combined stress markers presence variable

To enhance the statistical power of our study, we combined the data on *cribra orbitalia*, porotic

hyperostosis, and periostosis into a single variable of “presence of osteological markers of stress”. This approach allowed us to increase the sample size, albeit with somewhat simplified paleopathological information. We employed Kendall's tau correlation coefficient to examine the correlation between the combined variable and enamel hypoplasia frequency (**Figure 5**).

When tested for a correlation between the presence of enamel hypoplasia and the presence of osteological markers of stress, the results showed a weak positive correlation that was not statistically significant (Kendall's tau=0.151; $p=.122$; $N=106$). Subsequently, when we separated the sample by sex, the results for men showed a very weak negative correlation that was not statistically significant (Kendall's tau=-0.023; $p=.883$; $N=42$). For women however, a weak positive correlation was present, but again, it was not statistically significant (Kendall's tau=0.180; $p=.178$; $N=49$).

The presence of osteological markers of stress was correlated with the frequency of enamel hypoplasia as well, using Kendall's tau correlation

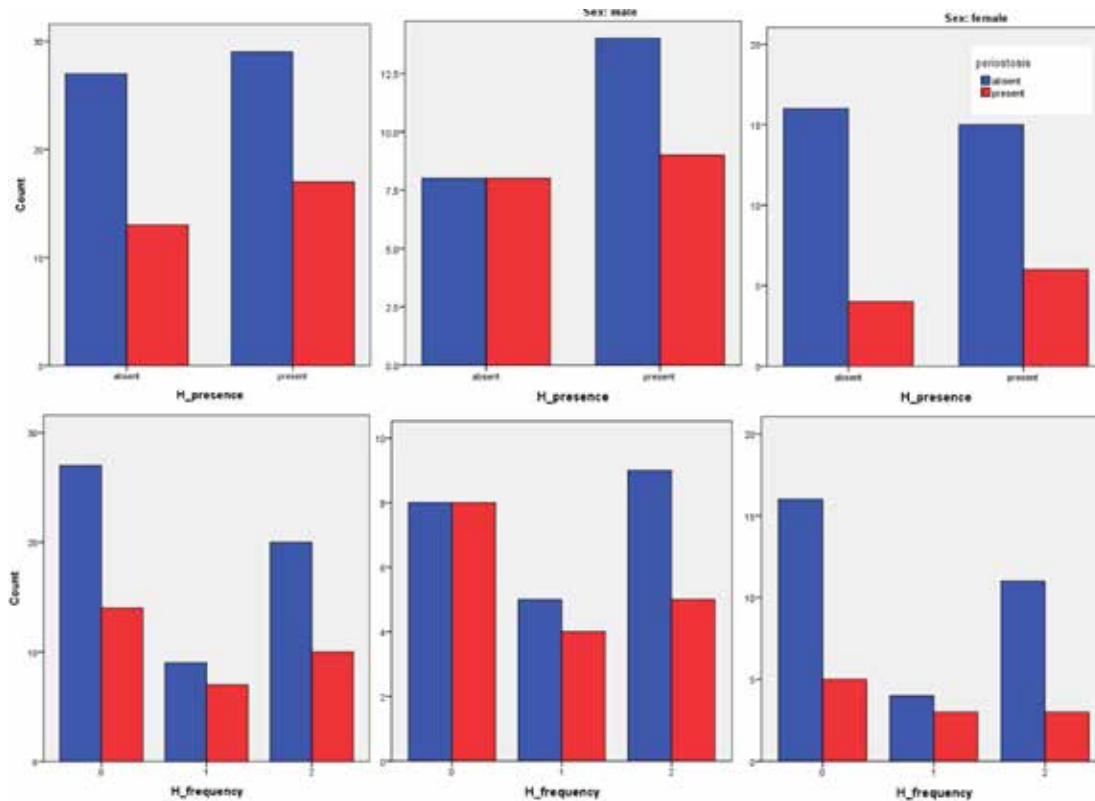


Figure 4. The presence of periosteosis compared to the presence (upper row) and frequency of enamel hypoplasia. Bar graphs to the left represent the whole sample, the middle ones are for the male and the far right are for the female sample (done using IBM SPSS Software).

coefficient (**Figure 5**). The results revealed a statistically significant weak positive correlation between the two (Kendall's tau=0.310; $p=.011$; $N=68$). When the sample was divided by sex, the correlation analysis for men showed a weak correlation that was marginally statistically significant (Kendall's tau=0.328; $p=.061$; $N=31$). Similarly, for women, the results indicated a weak correlation, but which was not statistically significant (Kendall's tau=0.246; $p=.154$; $N=33$).

Combined stress markers frequency variable

To further investigate the osteological markers of stress, we analysed their frequency, creating a variable that combines all data on the frequency of osteological stress markers. We created a 1-3 scale depending on the number of osteological stress markers recorded on an individual. Skeletons that were not sufficiently preserved for the observation of any of the stress markers were excluded from the sample. We then tested for a correlation between this variable and the presence of

enamel hypoplasia Kendall's tau coefficient (**Figure 6**). The results showed that there was a positive correlation that was statistically significant (Kendall's tau=0.302; $p=.011$; $N=68$). When we separated the sample by sex, the results for men showed a positive correlation that was marginally statistically significant (Kendall's tau=0.328; $p=.061$; $N=31$). For women the results showed a weak positive correlation that was not statistically significant (Kendall's tau= 0.246; $p=.154$; $N=33$).

We also examined the correlation between the frequency of osteological markers of stress and the frequency of enamel hypoplasia using Kendall's tau correlation coefficient (**Figure 6**). The results indicated a marginally significant weak positive correlation (Kendall's tau=0.206; $p=.065$; $N=69$). After dividing the sample by sex, the results for men showed a marginally significant weak positive correlation (Kendall's tau=0.310; $p=.061$; $N=31$). However, for women, the very weak positive correlation was not statistically significant (Kendall's tau=0.072; $p=.665$; $N=34$).

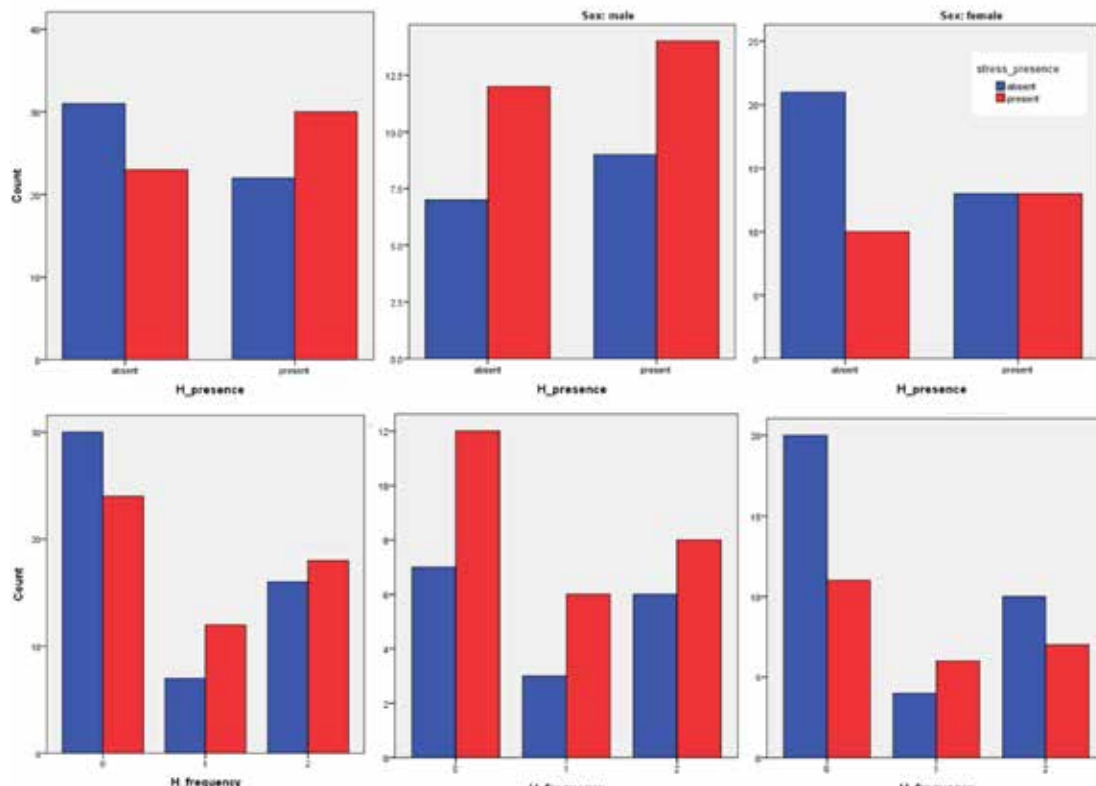


Figure 5. Combined stress markers' presence compared to the presence (upper row) and frequency of enamel hypoplasia. Bar graphs to the left represent the whole sample, the middle ones are for the male and the far right are for the female sample (done using IBM SPSS Software).

DISCUSSION

Our starting hypothesis was that the individuals who survived a period of physiological stress in their childhood would exhibit worse health outcomes later in life (Barker 2004: 31). To test this hypothesis, we observed enamel hypoplasia as a proxy for childhood stress (Goodman and Armelagos 1988; Goodman and Rose 1990; King, Humphrey and Hillson 2005; Lukacs, Nelson and Walimbe 2001; Minozzi *et al.* 2020), while osteological markers of stress, including *cribra orbitalia*, porotic hyperostosis, and periostosis, were examined in the skeletal remains of our study sample. To ensure the absence of confounding factors, we controlled for age-at-death and subsequently employed the collected data to validate our hypothesis.

Upon independent analysis, both *cribra orbitalia* and periostosis displayed no statistically significant correlation with the presence or frequency of enamel hypoplasia. Put differently, individuals who exhibited enamel hypoplasia as an indicator

of childhood stress did not demonstrate a heightened likelihood of developing *cribra orbitalia* or periostosis in adulthood. This finding held true for the entire study sample, as well as for each gender subgroup.

Among the 101 individuals whose remains were sufficiently preserved to allow for the detection of *cribra orbitalia*, only 21 individuals exhibited this pathology, with 9 of these individuals presenting no signs of enamel hypoplasia and the remaining 12 individuals displaying both *cribra orbitalia* and enamel hypoplasia. While the sample of individuals with *cribra orbitalia* was relatively homogenous, it was comparatively small, and although Kendall's tau suggested a weak positive correlation, the results of the analysis did not reach statistical significance.

In contrast, periostosis proved much more challenging for this analysis, due to the state of preservation of the skeletal material. As a marker of unspecified osteological stress (as opposed to the periostosis associated with local infection or fracture remodelling, for example) periostitis is

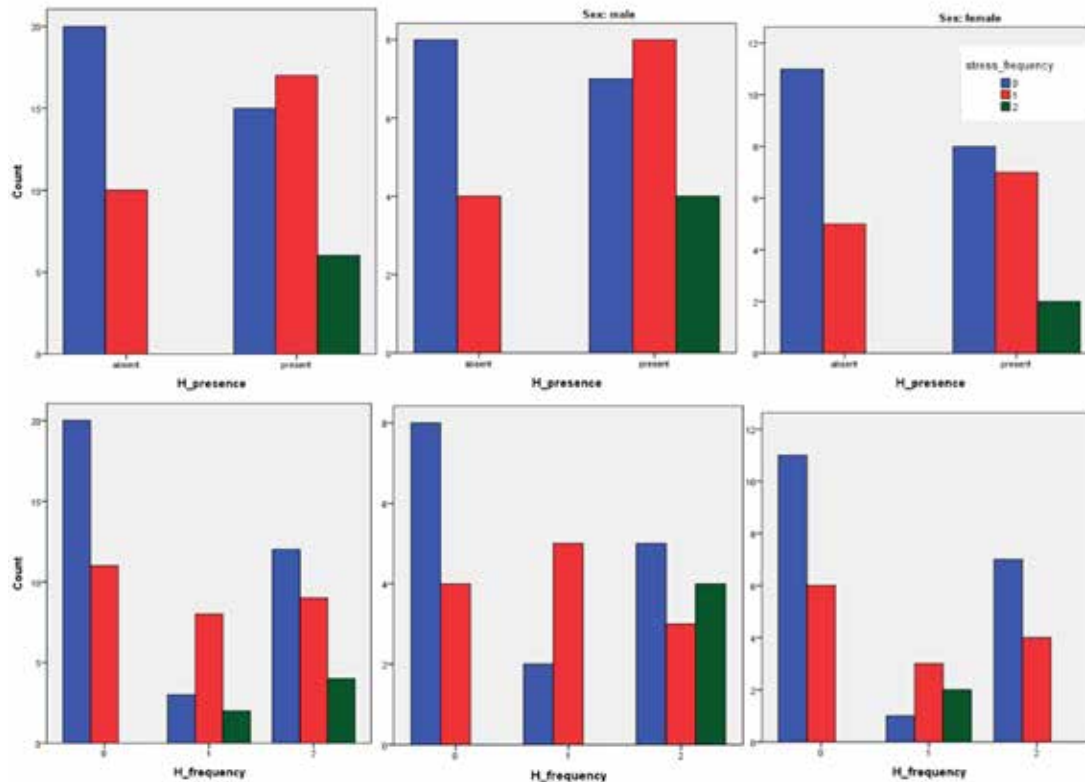


Figure 6. Combined stress markers' frequency compared to the presence (upper row) and frequency of enamel hypoplasia. Bar graphs to the left represent the whole sample, the middle ones are for the male and the far right are for the female sample (done using IBM SPSS Software).

most commonly found in the long bones of the extremities (Ortner 2003: 53). However, the absence of long bones or a lack of periostosis evidence in the present long bones does not necessarily indicate the absence of periostosis in an individual, since the missing long bones could potentially possess evidence of the pathology. Consequently, such individuals had to be excluded from our sample, which, in turn, reduced the robustness of our results.

Porotic hyperostosis was the only skeletal stress marker that showed a statistically significant correlation with the presence and frequency of enamel hypoplasia in our sample. However, the caveat to this finding is the modest sample size, as only 7 out of the 112 individuals included in the analysis presented with porotic hyperostosis. All 7 of these individuals displayed enamel hypoplasia as well, and were uniformly divided between sexes, with 3 males and 4 females affected. This outcome is noteworthy, especially when taking into account that *cribra orbitalia* did not demonstrate a similar correlation. One possible explanation is

that the anaemias associated with the occurrence of *cribra orbitalia* and porotic hyperostosis were symptoms of different illnesses (Rivera and Mirazon Lahr 2017: 17; O'Donnell 2019: 10; O'Donnell *et al.* 2020: 8–9). Additionally, given the extent of statistical testing performed on this sample, and considering that the correlation between porotic hyperostosis and enamel hypoplasia only achieved statistical significance when comparing the entire sample and women with the presence of enamel hypoplasia or men with the frequency of enamel hypoplasia, this result may be a statistical coincidence.

The utilization of consolidated variables for analysing the correlation between enamel hypoplasia and osteological markers of stress proved to be the most promising approach. Using these consolidated variables, we were able to test for a correlation between the presence and frequency of enamel hypoplasia and the presence and frequency of osteological markers of stress, regardless of their type. What we lost in precision we gained in the enlarged sample and broadened scope of the

health status analysis. The consolidated variable of the presence of osteological markers of stress was defined in this study as being present if an individual exhibited any of the osteological markers of stress that were analysed. The consolidated variable of frequency, on the other hand, noted the number of different types of osteological markers of stress that were present in each individual. It should be noted that individuals who could not be observed for one or more of the osteological markers of stress were excluded from the sample in order to ensure the accuracy of the results.

The consolidated variable of the presence of osteological markers of stress did not demonstrate a statistically significant correlation with the presence, but it did show a positive correlation with the frequency of enamel hypoplasia, which was significant. Interestingly, when divided into groups by sex, the results again show a positive correlation, which was marginally significant for the male sample, but not statistically significant for the women. One explanation could be that there are different mechanisms influencing male and female health status that could stem from both fertility or horizontal and vertical social status, but the more likely explanation is the small sample size (31 for the male sample and 33 for female). The small sample size does not exclude other influences, but those would be hard to prove with such a limited number of individuals.

On the other hand, the consolidated variable of the frequency of osteological markers exhibited a marginally statistically significant positive correlation with both the presence and frequency of enamel hypoplasia. The same trend found with the first consolidated variable was apparent here as well – when testing the whole sample and the male sample, a marginal significance is there, but the result of the female group is, yet again, statistically insignificant. The sample size is the same as with the previous test (31 males and 33 females), so we could apply the same logic as with the consolidated variable of the presence of osteological markers – the sample size precludes us from drawing any meaningful conclusions on the potential differences of health status between men and women without further analyses.

Based on our results, it is clear that relying on a single or just a few osteological markers of stress is overly ambitious when attempting to assess the

health status of an individual. While useful in other analyses, osteological markers of stress, which already lack a clear etiology in most (if not all) cases, cannot provide a comprehensive picture of a person's health on their own. Even putting aside the problems stemming from the preservation status of skeletons, which could be poor, especially for prehistoric populations, the mere absence of osteological markers of stress does not necessarily mean that the individual in question did not suffer a disease invisible to physical anthropology. However, the constraints of archaeological material and limitations of currently available methodologies in bioarchaeology should not discourage us from pursuing viable ways of using the data that we can gather and quantify. As demonstrated by our analysis of the consolidated variable of the frequency of osteological stress markers, a macroscopic approach can be sufficient, particularly when dealing with a limited sample size. Although this method does involve some loss of information and a simplified view of an individual's health, it can still be valuable when assessing the health status of a population.

CONCLUSION

In our study, the results suggest that those individuals who survived multiple stress episodes during childhood, indicated by the presence and higher frequency of enamel hypoplasia, had comparatively worse health outcomes, indicated by a higher frequency of osteological markers of stress, than those individuals who did not experience childhood stress. This result is in line with the DOHaD hypothesis, which posits that surviving childhood stress leads to negative health outcomes later in life. It should be noted that using a single osteological marker of stress for this type of health status analysis proved to be too ambitious. Due to sample size constraints at this moment, we cannot offer any meaningful conclusions regarding the potential differences in the health status of the men and women of this population.

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Odnos zdravstvenog statusa i društvenog položaja u bronzanodopskoj kulturi Moriš: nekropole Mokrin i Ostojićevo/Relationship between health and social status in the Bronze Age culture of Maros: Mokrin and Ostojićevo necropolises, and was defended at the Faculty of Philosophy, University of Belgrade, in July 2022.

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REZIME

BOLJI ZUBI, BOLJE ZDRAVLJE? ODNOS IZMEĐU HIPOPLAZIJE ZUBNE GLEĐI I SKELETNIH MARKERA STRESA U RANOBRONZANODOPSKIM POPULACIJAMA SEVERNE SRBIJE

KLJUČNE REČI: HIPOPLAZIJA ZUBNE GLEĐI, SKELETNI MARKERI STRESA, DOHAĐ HIPOTEZA, ZDRAVLJE, RANO BRONZANO DOBA, KULTURA MAROŠ.

Rano i srednjebronzanodopska kultura Maroš bila je predmet mnogih arheoloških istraživanja koja su imala za cilj odgovoriti na pitanja društvenog usložjavanja, statusa i načina života. Arheološki i skeletni materijal s nekropole Mokrin i Ostojićevo više puta je korišćen da odgovori na pitanja o statusu, ishrani, fizičkoj aktivnosti i srodstvu. Iako su neki aspekti života nosioca maroške kulture postali jasniji, neophodne su detaljnije informacije o zdravstvenom stanju ovih bronzanodopskih populacija za dublje razumevanje društvenih mehanizama i normi kulture Maroš.

Ovaj rad bavi se pitanjem zdravstvenog statusa populacija sahranjenih na nekropolama Mokrin i Ostojićevo oslanjajući se na skeletne markere stresa i hipoplaziju zubne gleđi. Naša hipoteza drži da su individue koje su u detinjstvu preživele epizodu stresa, koja je ostala zabeležena kao defekat gleđi, posledično imale veće šanse da svoju uvećanu osetljivost na infekcije i bolesti ispolje kroz veću prisustnost skeletnih markera stresa. Analiza je uređena uzimajući u obzir teoriju osteološkog paradoksa, te uz kontrolisanje starosti individua, prateći korelacije između hipoplazije zubne gleđi i kribre orbitalije, porotične hiperostoze i periostoze.

Rezultati ukazuju da svođenje zdravstvenog statusa na praćenje samo jednog skeletnog markera stresa nije odgovarajući pristup, posebno kod relativno malih skeletnih serija. Analize koje su

se koristile konsolidovanim varijablama prisustva i frekvencije skeletnih markera pokazale su se kao bolji pristup. Učestalost osteoloških markera stresa dalo je statistički značajnu korelaciju sa prisustvom i učestalošću hipoplazije zubne gleđi, te ukazuje na važnost praćenja više različitih markera stresa prilikom procenjivanja skeletnog statusa populacija u prošlosti.

* * *

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RECONSTRUCTION OF THE ARCHAEOLOGICAL GRID LAYOUT IN THE AREA OF THE *FORUM OF MUNICIPIUM DD*

ABSTRACT

Many years of neglect of certain antique sites in our region can often cause not only their deterioration in the field, but also the misplacing of important parts of documentation linked to their archaeological research. Due to already familiar historical, war-related and political circumstances in the area of Kosovo and Metohija, studies of results of previously conducted archaeological research activities on certain sites are often limited due to the absence or incompleteness of parts of the documentation. Such is the case with the antique site of Municipium DD in the area of today's Sočanica.

On the basis of the preserved part of the documentation (mainly, archaeological journals), we had the possibility of forming a better interpretation of the circumstances in which certain find were discovered. However, the absence of a part of the technical documentation (plans and drawings) prevented us from gaining, in a well-founded manner, an understanding of the archaeological context as a whole from the very start. One of the largest problems was the lack of a grid layout, according to which the research was organised, and which obviously existed, as can be seen from the archaeological journals. In order to gain a better understanding of the archaeological context, it was necessary to reconstruct its position in the area of the forum of Municipium DD.

KEYWORDS: RECONSTRUCTION OF THE COURSE OF THE ARCHAEOLOGICAL RESEARCH, GRID LAYOUT, METHODOLOGY OF THE ARCHAEOLOGICAL EXCAVATION, ARCHAEOLOGICAL UNITS, *FORUM, MUNICIPIUM DD, SOČANICA*.

INTRODUCTION

In our experience, revisiting the results of research of sites that have not been the subject of research activities (both in the field and as scientific papers) for several decades, or at least recently, often involves the absence of a part of the documentation. This is a particularly common occurrence in the territory of the former SFRY, whose acrimonious disintegration led to fallouts among workers from protection institutions (museums, in the case of mobile findings, and institutes for the protection of monuments, in the case of immovable heritage), most often on a national basis. This resulted in a situation in which one part of the

mobile material and documentation remained at the original location or in competent institutions, while the other was dislocated. In both cases, they would be accessible to one side, while for the other side, access would be, at best, limited.

This difficult situation also affected immovable heritage from Antiquity. In the case of the north of Kosovo and Metohija, while one side is interested in the activities of the prehistoric society, and the other is interested in the activities of the medieval Slavic population, primarily in the spiritual realm, there is usually no mention, unfortunately, of the preservation of the immovable heritage from the Antiquity period in the field. Political events adversely affected the social status of the population

in this part of Kosovo and Metohija, resulting in a situation in which the antique heritage is almost at the bottom of the list of concerns of the local community (Савић 2013).

All these circumstances have had an unfavourable effect on the state of the documentation as well, which has been scattered or lost, thus making it more and more difficult to be traced with the passage of time. One such important antique site is *Municipium DD* (**Figure 1**), about which, apart from a published monograph by Emil Čerškov, there have been no significant studies in the last sixty (!) years that would deal with the results of excavations conducted in the 20th century, aside from general overviews of the Roman presence in Kosovo and Metohija and treatments of minor individual topics (Čerškov 1970; Фидановски 1998; Милин 2002; Гугољ и Тешић-Радовановић 2013; Бјелић и Савић 2020; Ferri 2022).

The published monograph by Emil Čerškov, a pioneer in systematic archaeological research of antique sites in Kosovo and Metohija, deals with the period of research from 1959 to 1965. Although in today's sense, it could be seen with certain shortcomings, for the time in which it was published it represents exceptional content. On a broader scale, the published work by Čerškov must also be seen in the context of the increase in the intensity of scientific research activities, the

number of institutions and personnel dealing with ancient history, and archaeology in post-war Yugoslavia (Mihajlović 2023: 463; Novaković 2021: 164). *Municipium DD* and Ulpiana are the largest antique urban centres in Kosovo and Metohija where extensive archaeological work was carried out with the levels of archaeological methodological practice implemented (Mihajlović 2023, 468-470). Unfortunately, the methodology, as well as the available funding for most archaeological research in that period, often did not sufficiently take into account a larger volume of drawings, detailed descriptions, and measurements in technical documentation that would cover an important segment of the scientific research work (for an analogy on this question see: Đorđević and Karović 2021: 39).

Through the kindness of my colleague Marija Savić from the Institute for Serbian Culture Priština (with a temporary seat in Leposavić), I was informed that a part of the documentation (archaeological journals) from the research of *Municipium DD* existed in the Institute for the Protection of Cultural Monuments of Serbia, (in the following text: IPCMS) Belgrade. Colleagues from this institution kindly sent me scanned black and white copies of the journals, on the basis of which the interpretation of the archaeological context began. It soon became clear that many unknown factors



Figure 1. General view of the archaeological excavations in the area of the *forum* of *Municipium DD* in Sočanica (Documentation of the Institute of Archaeology, Belgrade).

would appear during this process due to the lack of technical documentation.

In the documentation that we received from the IPCMS, there is an important segment missing: the plan of the grid layout according to which the archaeological research in the area of the *forum* of *Municipium DD* was organised, and which the researchers, incidentally, constantly refer to in their archaeological journals. Without them, it would be unclear in which places one should look for a given find, in terms of both mobile archaeological finds, but also those of special types (architectural decorations and epigraphic elements). Also, the layout of the walls of older buildings remained unclear, which were discovered under the foundations of buildings A and C, since older researchers would usually register their location on the basis of cardinal points within a given part of the grid layout. The same problem is also present in the most important building of *Municipium DD* – the Temple of Antinous (**Figure 2**), as it seems that, with the passage of time, and in given journals, it was listed under different names (water tank, temple, room D, room α , room γ , etc). We should

also take into consideration different approaches to archaeological journals by certain researchers, since they would sometimes offer only very summary descriptions; another factor that should be taken into consideration their different handwriting. The reconstruction of the grid layout in the area of the *forum* of the *Municipium DD*, thus, became a painstaking process of seeking individual mentions of given architectural parts of buildings and linking them to the spatial distribution, in the form of a grid layout, in the area of the *forum*. One of the main goals was to connect data and reconstruct entities that had been researched over a long period of several decades ago (a good example of this practice is present in the recent interpretation of the antique remains in the area of the former library in Kosančićev venac, see: Đorđević and Karović 2021: 37-41).

Although it was initially obvious from the archaeological journals that the entire space was divided into smaller segments (squares), without a grid their layout was unclear, as was the system according to which the researchers would assign special markings to these spaces, and the dimen-



Figure 2. View of the remains of the Temple of Antinous (Documentation of the Institute of Archaeology, Belgrade).



Figure 3. Interior of *horreum* C (Documentation of the Institute of Archaeology, Belgrade).

sions of the individual squares. For buildings A and C (western and eastern *horreum*), it was clear from the start that the research was organised into smaller square-shaped areas according to the interior division of space, affected by the regular distance between pillars and pilasters on the walls (**Figure 3**). However, the marking system remained unknown in their case as well. Area B was located between the previously mentioned buildings. Determining the size of the squares and their layout during the marking in this area was completely unclear, since it was observed that the squares were divided into smaller segments (journal of archaeological research (hereinafter: AFJ), from June 14th 1961), and that each square did not have the same number of segments. Additional confusion was introduced by a researcher's note that the dimensions of these squares were not equal (AFJ, June 8th 1961). The same also applied to the most important building of the entire *forum* – the Temple of Antinous. Bearing in mind the fact that this is one of the few pagan temples from the Roman period known in the area of the Central Balkans, it is apparent how much of a problem the lack of knowledge on the

archaeological research context can be in any interpretation of this building.

Aside from the archaeological journals, the posthumously published dissertation of Emil Čerškov, head of the research, was certainly most helpful. The plans from the monograph and the existing situation in the field made it possible to more easily recognise certain parts of the buildings mentioned in the archaeological journals (Čerškov 1970: prilog (attachment) III) (**Figure 4**). The mentioned parts of the buildings represented the basis for the interpretation of the edges of individual squares of the grid layout.

BUILDING A

Building A is characterised by an elongated base with two rows of pillars in its interior. Čerškov identified it as a *horreum* (Čerškov 1970: 15). There is a sequence of pilasters on its walls, whose position is coordinated with those on the opposite walls and with the position of the pillars, thus, the interior space is divided into smaller parts in the shape of squares. By gradually matching and

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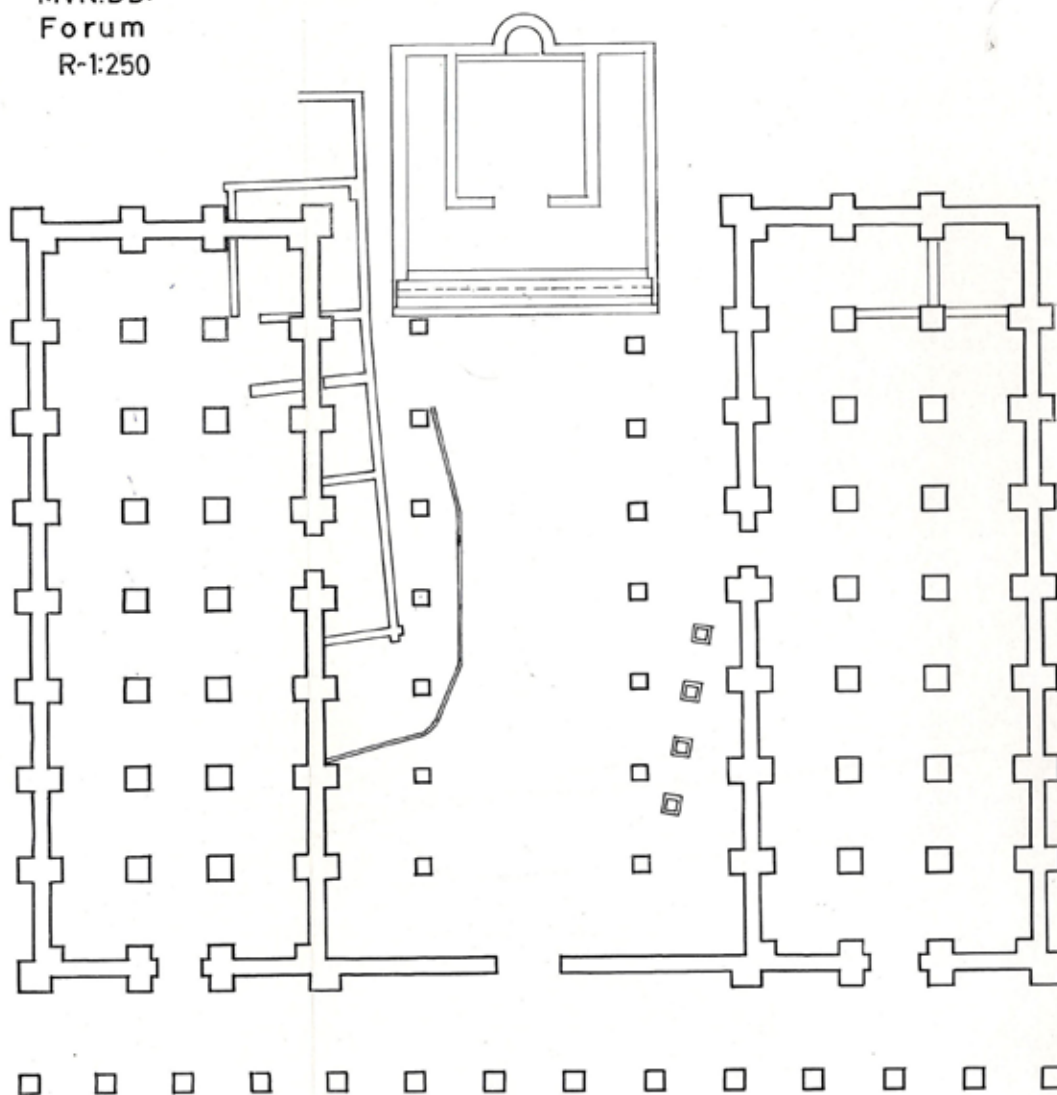


Figure 4. Foundations of the researched constructions in the *forum* of *Municipium DD* (Čerškov 1970, attachment III).

combining data from the archaeological journals, it was possible to determine the position of the squares, pillars and pilasters that were mentioned in the archaeological journals with the indicated markings. The chronological order of the excavations is indicative for their marking; therefore, we will follow this sequence further in this paper.

Systematic archaeological research activities in building A began with excavations in squares 1–3, which are said to have extended along the northern wall 1 (AFJ, August 2nd 1960). For square

3, it was stated that the remains of pillar II, on the opposite side from pilasters 2 and 3 (AFJ, August 3rd 1960), were discovered along the southern profile; those pilasters were connected to the previous ones by more recent walls. Pillars I and II were also connected by a similar wall. The plan published by Čerškov (Čerškov 1970: prilog III) indicates that the mentioned pillars must have been the northernmost in the interior of the building. It was still uncertain from which side the numbering of these pillars was performed and, thus, which

pillar is no. I and which is no. II. Squares 4, 5 and 6 were discovered in the continuation of the works and it was noted that, once they were excavated, all sides of pillars I and II were discovered. At the same time, it was emphasised that pilaster 18 was located on the opposite side from pillar I (AFJ, August 6th 1960).

When it comes to the door on the western wall, it was stated that it was flanked by pilaster 15, but it was not specified whether it was located to the south or north of this door (AFJ, August 6th 1960). In the same building, the entire area of the southern wall 3, where pilaster 11 was located, in the immediate vicinity of the door, was discovered during this year (AFJ, August 3rd 1960). The discovery of the pillars of an older building located under building A is also linked to the same date, while the remains of a more recent wall, standing diagonally in relation to wall 2, were discovered on the following day. A more recent wall was discovered in the area of square 12 (AFJ, August 10th 1960). Comparing this piece of information with the mentioned plan by Čerškov, we reached the conclusion that this square must be one of those in line with the door in the western wall of the building. When it comes to square 24, it is known that it comprehended one of the corners of the interior of the building, but it is not specified which one (AFJ, August 10th 1960).

Archaeological notes from August 11th 1960 made it possible to define individual pillars as corner pillars of certain squares. Thus, pillars V and VII belong to square 10, and pillar VI belongs to square 12. Squares 15, 18 and 21 belong to the same sequence. At this point, the particulars provided were not sufficient for us to be able to define the position of the squares and the pillars, but they did help in locating them with more precision later on.

The marking of the pillars was possible due to the fact that in one of the archaeological journals there was also an accompanying sketch for a part of the space inside the building (AFJ, June 8th 1961) (**Figure 5**). According to this, the third pillar (viewed from the north towards the south, and in the western half of the building) was marked with the number V, while the pillar next to it (in the eastern half) was marked with the number VI. South of pillar V was pillar VII, and south of pillar VI was pillar VIII. Based on this, it was possible

to reconstruct the order in which the pillars were marked and numbered. The first one would have been in the north-western part, and the second pillar in the north-eastern part of the area. Further numbering would have followed the same procedure in each subsequent row, thus, the last registered pillar in the row bore the number XIV and was located in the south-eastern part of the area.

The marking of the pilasters proved to be a more complex task. Let us begin with the data we already knew. Pilaster no. 16 was located to the west of pillar VI, and pilaster no. 15 to the south of it. At this point, it is necessary to bear in mind the fact that pilaster 18 was located across from pillar I; thus, we obtained a clarified sequence of pilasters marked from 15 to 18 on the western wall. It is evident that the marking of the pilasters was performed in a clockwise direction. In doing so, there was one obvious problem, as the first pilaster would be the one to the east of pillar II, which is unusual, as marking would normally start from a pilaster at the corner of the building. Since the journals mention numbers ranging only from 1 to 18, the pilasters on the northern wall would have remained unregistered. Other discrepancies would occur as well. In earlier notes, it was clearly indicated that wall 2 was the one on the eastern side (AFJ, June 14th 1961), with pilasters 6, 7, 8, 9 belonging to this wall (AFJ, June 9th 1961 and AFJ, June 13th 1961, AFJ, June 14th 1961). However, if all the pilasters were marked according to the previous system, this would mean that pilasters 8 and 9 were located on the southern wall 3, suggesting that some pilasters were excluded from this process.

It is somewhat easier to decipher the marking of individual squares inside the building. Square 14 is the first that can be linked to a given pillar, namely, pillar VII (AFJ, June 15th 1961). The determination of the location of square 20 next to pillar XIV is linked to the same date. It was evident that the mentioned pillars form the corners of the mentioned squares. A more specific location can be determined only for square 10, where the western entrance of building A was found (AFJ, June 15th 1961). It belongs to the sequence of squares 7–10–13–16–19–22 (AFJ, June 20th 1961) in the western part of the building. Judging by the quantity and registration of the mentioned squares, it is evident that the said sequence was

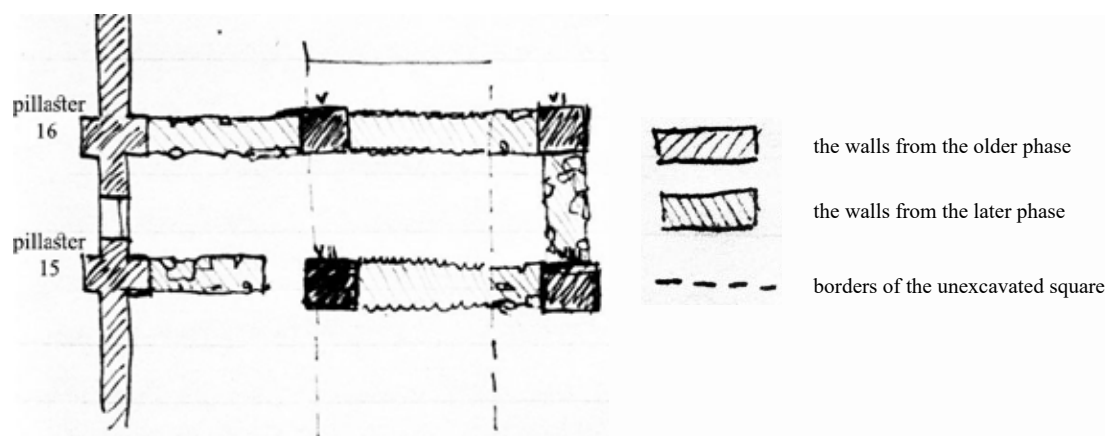


Figure 5. Sketch of the plan with the later phase of the walls between the pillars of the older phase in building A (from one of the archaeological journals kept during the excavations).

placed in a north–south direction. Researchers indicated that squares 8 and 11 were adjacent (same date). According to the notes, the southern door of building A was located in square 23 (AFJ, June 20th 1961). Squares 14, 17 and 20 belong to the second sequence of squares (AFJ, June 21st 1961). Its orientation must be the same as that of the previous one, since none of these squares are listed in the group where the numbering precedes that of the new sequence. The south-western corner of the building belonged to square 22 (AFJ, June 28th 1961), which is in agreement with the previously mentioned sequence of squares in the western third of the building and indicates its correct orientation.

By combining all the previously mentioned data, we were able to reliably reconstruct the marking of the squares. The north-western corner of the area is logically marked with number 1. The marking of the other two squares as carried out from east to west, which was also applied to each subsequent row. Within other rows, the same method of marking was observed, by giving the first square in each subsequent row the number which followed the last one in the previous row (Figure 6).

The clarification of the marking of the pilasters could only be performed after the previously deciphered numbering of the pilasters and squares. At first, it was indicated that pilaster 10 belonged to the southern wall 3 and that it formed one of the flanking elements of the door on this wall (AFJ, June 20th 1961). Let us recall that the same was previously stated for pilaster 11, hence, it is evi-

dent that one pilaster was on one side of the door, and the other on the other side. Also, the registering of the walls matched with the one defined in the previous year. From there, it is clear that wall 2 was the one on the eastern side of building A and that, according to earlier notes, the sequence of pilasters 6–7–8–9 belonged to it. From the previous two pieces of information, it is clear that in the marking of the previously mentioned pilasters, only no. 10 and no. 11 were located on the southern wall 3. Since pilaster 10 was one of those two closest to the door, it became evident that the pilasters at the corners of the building were not marked with numbers. It follows that the numbering of the pilasters started from the northern wall, with only the central pilasters marked with 1 and 2. The pilasters on the eastern wall 2 were marked from the north to the south with numbers from 3 to 9, and the pilasters on the western wall of building A were given numbers from 12 to 18 (Figure 6).

AREA B

Area B is located between buildings A and C, which represent two *horrea*. The first research activities of the borders of area B can be dated to 1960. It was discovered, at that time, that the southern wall of building A (wall 3) extended and formed the southern edge of area B (AFJ, July 29th 1960). At a somewhat later point, the pillars of the southern portico of wall 3 were discovered, in the section south of the south-western pilaster of building A (AFJ, July 30th 1960).

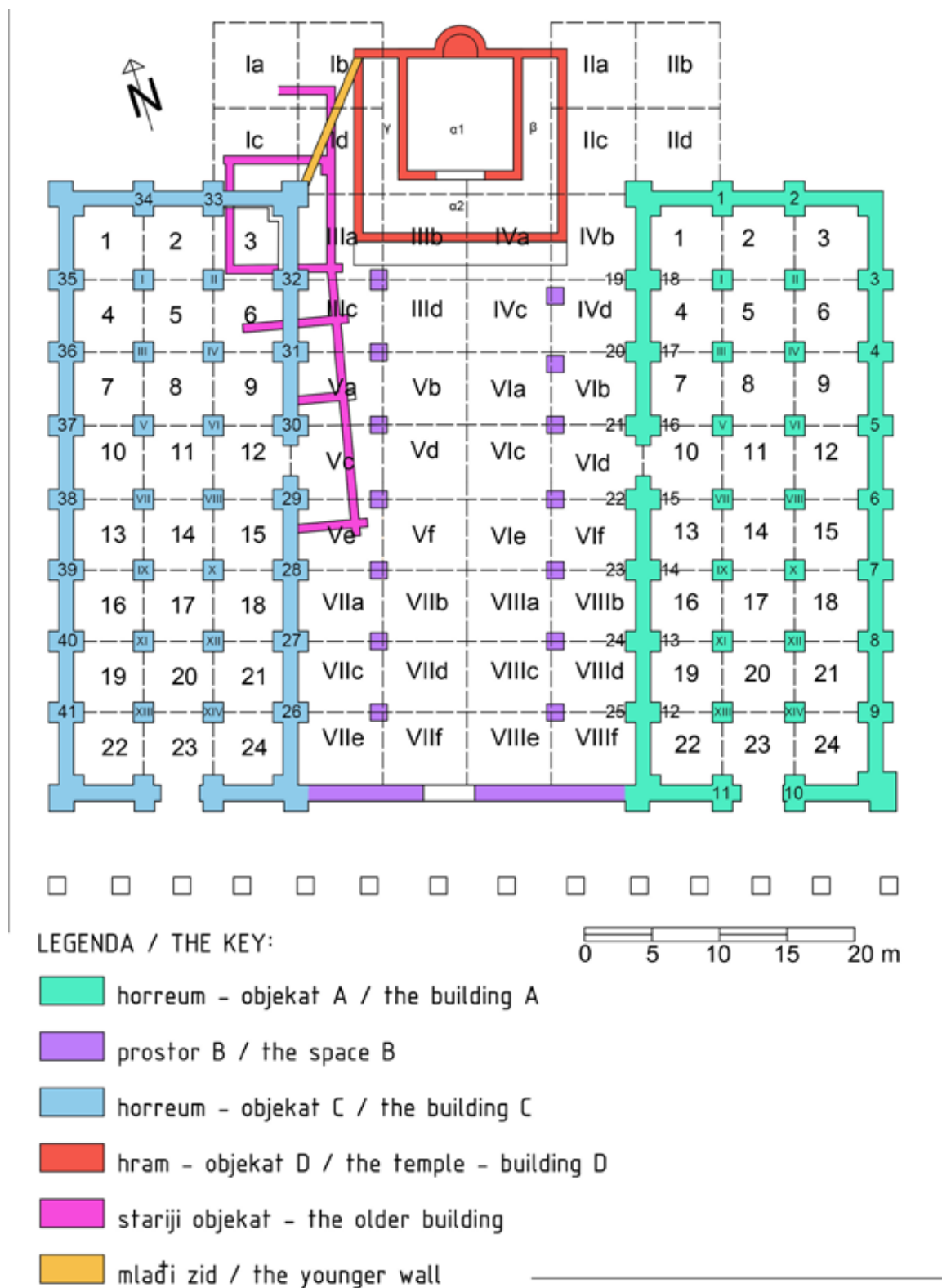


Figure 6. Reconstructed grid layout from the archaeological research of the *forum* of *Municipium DD* (drawing by the author of the paper).

Area B was divided into squares together with areas north of buildings A and C. Each of the squares was divided into a number of segments. The squares were divided into segments marked with the first letters of the Latin alphabet from a to c (four segments each); however, when it comes to squares VII and VIII, it can be seen that there were more of them, and they were marked from a to f (six segments each).

Unfortunately, due to the lack of a large part of the technical documentation, the dimensions and layout of these squares remain unknown. Let us remember here that the journals recorded that the dimensions of these squares were not identical (AFJ, June 8th 1961), which further complicates matters regarding the previous questions. In order to determine the unknown layout, numbering and dimensions of individual squares in this area, it was necessary to follow the records in the archaeological journals and compare them with the foundations of the buildings, published by Čerškov (Čerškov 1970: prilog III). As with building A, the best way to determine their markings and size was to follow the excavation chronology, combining and matching the data on individual squares whose markings were indicated in the journals.

Most of the archaeological journals from 1961 and 1963 have been preserved, therefore, the chronology of the excavations can be reconstructed in individual fragments from them. During the research in 1961, within area B, squares IIIa, IIIc, IIIId, IVb, IVc, IVd, Va, Vc, Vf, VIb, VIId, VIIf, VIIb, VIIc and VIIIf were investigated. As part of the next research period, in 1963, squares Ic, Id, IIIa, IIIc, IVc, Va, Vc, Ve, Vf, VIb, VIId, VIIa, VIIc, VIIe, VIIIf, VIIId and VIIIf were investigated (**Figure 7**). In 1963, the layout of the extensive walls of the temple and building C, as well as the line of the pillars of its portico (AFJ, June 28th 1963) and the extensive walls of building A were already known. However, there is no mention, in any of the square areas that were opened in 1963, of the pillars of the portico of building C, therefore, it was problematic to link the borders of the squares with these architectural elements on the basis of the journals from this year.

In the journal for 1961, the pilasters on the outer face of the western wall of building A were designated with numbers from 19 to 32, the same as those on the eastern wall for building C. In both

cases, the corner pilasters were not numbered, as we have already pointed out previously. By comparing this numeration of the pilasters on the western wall in 1961 with the one presented in the previous part, we came to the conclusion that an error had obviously occurred and that the pilasters on the western wall had been registered twice. Moreover, every pilaster on all the other walls of building A had the same number on the outside and inside of the wall. The reason obviously lay in the circumstance whereby the works inside building A were headed by one archaeologist, and the works in area B by another, which can also be seen from the journals, by the different handwriting. The aforementioned inconsistency required that the marking of the pilasters on the side of building A facing area B should be deciphered again.

The marking of the squares in area B was carried out with numbers from IV to VIII. Since each of them was characterised by a special size, position and number of segments, we will list the more important elements that helped us locate each individual square and its segments.

For square IVd, it was only stated that it included the discovery of the [foundational – author's note] base of one of the pilasters. It was not specified exactly to which pilaster this refers, and it is only clear from the context of the research that it belonged to building A. Based on that, it can only be stated that the mentioned square belongs to a sequence of squares stretching along the line of the portico of building A.

Inside square Vf, in the north-western part, a base of a pillar was discovered (AFJ, June 6th 1961), and it was noted that it was “analogous” to the other one in square VIId. Another pillar base was discovered in the south-western part of the same square. Therefore, it is apparent that the mentioned bases represent the corners of trench Vf. In this square, researchers also registered a lead pipe that ran towards the north along the entire length of the square (AFJ, June 21st 1961). Thanks to the plan published in the dissertation by E. Čerškov (Čerškov 1970: prilog III), we know the location of this pipe.

As for square VIId, it was stated that it was bordered [on the eastern side – author's note] by pilasters on both sides of the door (unfortunately, it does not say what numbers they were marked with). However, the previous piece of information

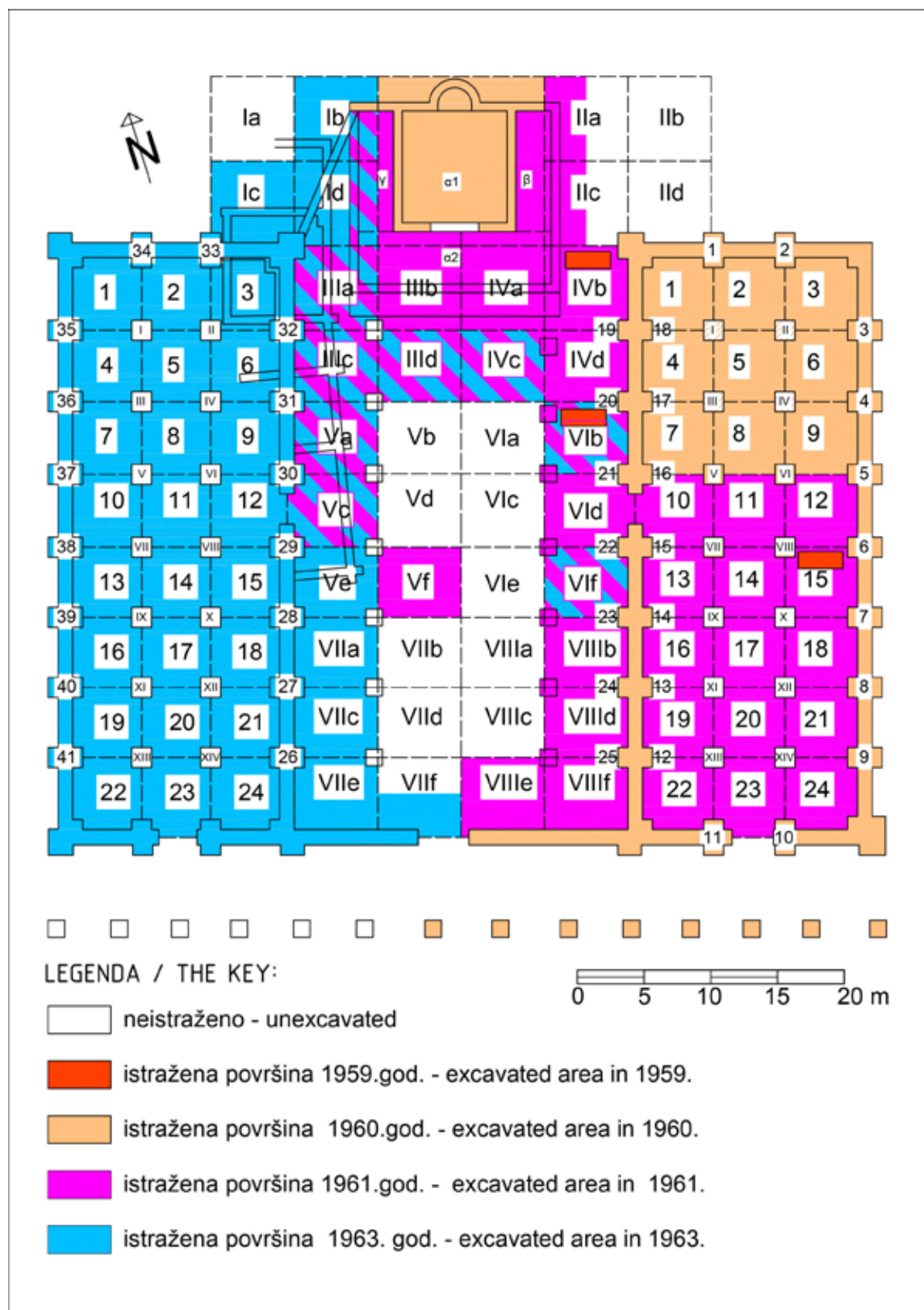


Figure 7. Reconstructed excavation chronology in the area of the *forum* of *Municipium DD* (drawing by the author of the paper).

made it easier for us to define the position of the mentioned square, as well as to define its length in the north–south direction (AFJ, June 17th 1961). Due to its position, it comprehended the entrance door on the western wall of building A, extending from the pilaster south of said door up to the pilaster that was further north of it. When it comes to square VI_f, it was stated that it included one of the bases of the portico of building A, and later it was specified that it stood on the opposite side from pilaster 22 on the western wall of the mentioned building (AFJ, June 18th 1961). This piece of information indicates that the mentioned square belongs to a sequence of squares stretching along the line of the portico of building A. Minor excavations were carried out in square VI_b in 1963 (AFJ, August 20th 1963).

Pilasters 27, 28 and 29 were placed in the context of square VII, namely, its segments a, c, e (July 13th 1963). However, when it comes to pilaster 29, it is clear that it could not have belonged to the mentioned square because it was quite far from it and, instead, it belonged to squares V_c and V_e, as we established earlier.

In square VII_a, works did not last long (one excavation layer), before being halted, because further exploration of this area interfered with the removal of soil; therefore, nothing more can be said about its position. As for square VII_e, it is stated that the south-western corner of area B also belonged to it (AFJ, July 12th 1963), and also that it comprehended at least a part of pilaster 26 (AFJ, July 11th 1963). This piece of information is also confirmed by a note stating that next to the “south-eastern corner pilaster” (the cardinal direction is indicated in relation to building C, to which the pilaster belongs), a larger number of broken bricks appeared along the southern side of the segment – next to the wall (which obviously delimits area B). It follows that square VII_e encompassed the south-western corner of area B. It was stated that only half of the surface of square VII_f was comprehended in order to reveal the wall. This indicates that no other constructional structures had been previously registered in the area of this segment, which would have required the entire surface to be examined, and only the wall was uncovered, which was also present in the neighbouring segment VII_e (July 29th 1963). This is specified in the part where it was stated that

the trench was extended along the southern wall, since the floor level was previously reached in segment VII_e (July 30th 1963). The previous statement indicates that square VII_f had to be found further east than square VII_e, whose position was previously determined.

When it comes to square VIII_b, it was stated that its corners on the eastern side were formed by pilasters 23 and 24 of the western wall of building A, while its western corners were formed by two bases of the portico of the same building, at a distance of 1.82 m from the wall (June 15th 1961 and June 17th 1961). This piece of information indicates that the mentioned square belonged to a sequence of squares that stretched along the line of the portico of building A. In 1963, excavations were performed in square VIII, in the area of segments e and f. As for segment VIII_f, it was only stated that the situation was the same as in square VII_f, where a wall followed along the southern side of the trench (August 30th 1963 – August 31st 1963). Segment f was formed next to the aforementioned wall, as can also be seen from data recorded on July 29th 1963. The aforementioned data indicates that squares VII and VIII were symmetrical and that both extended along the southern wall of area B, the former occupying the western half, and the latter the eastern half. When it comes to square VIII_d, it is only stated that a large amount of stone and rubble was removed (AFJ, July 3rd 1963 and July 31st 1963).

Earlier, we pointed out that the base registered in square V_f, according to researchers, was “analogous” to the one in square VI_f (AFJ, June 20th 1961). This indicates that squares V and VI were placed on opposite sides to each other, hence, the bases excavated in them were symmetrical. In that case, square VI would be analogous to square V, and square VII would be analogous to the square marked with the number VIII. When it comes to the last-mentioned squares, we should bear in mind, to begin with, that those were the only squares divided into a larger number of segments (marked from a to f) during the research, confirming the thesis regarding the symmetry of the positions and dimensions of the mentioned squares. At the same time, this observation indicates that area B was divided into squares marked with odd numbers on the western side, and even on the eastern side. However, we can also identi-

fy the marking of the segments of these squares. The squares were divided into smaller segments along the directions north–south and east–west. The first segment of each square (north-west) is marked with the letter a (see square VII in this part), and the second (north-east) with the letter b (which can be seen in the case of segment VIIIb). The south-easternmost segment was marked with the last letter available, which differed depending on the number of segments into which the square was divided. In squares V and VI, such a segment was marked with the letter d, while in squares VII and VIII – with the letter f. The borders of the segments on the line of the porticos of buildings A and C were determined by the position of the portico bases and pilasters on their walls (**Figure 6**).

The aforementioned spatial division of squares into smaller segments is also confirmed by the division present in the area of the older building discovered under building C, which will be discussed further in the text.

BUILDING C

Building C is characterised by a spatial and structural distribution symmetrical to that of building A. However, precisely because of the aforementioned symmetry, it was not clear how the numbering of individual squares, pillars and pilasters was carried out. Therefore, in order to secure the reliability of the interpreted data, the deciphering of the marking of its spatial and structural elements had to be carried out independently of that previously done for building A, located to the east of building C.

On the northern side of this building, one can initially single out squares, pilasters and pillars whose designations can be easily determined according to their position (relative to the cardinal directions) recorded in the archaeological journals. In square 3, the eastern and northern walls are registered (AFJ, July 17th 1963), therefore, it is clear that it comprehended the area of the north-eastern corner of the interior of building C. The north-eastern corner is not marked, which was a practice used in the marking of building A as well. The adjacent corner of this square is formed by pilaster 33 on the northern wall (AFJ, July 31st 1963). From certain notes, it can be concluded that pilaster 34 was to the west of it, also

on the northern wall (these pilasters together were listed as belonging to the said wall), and a little further to the west was the north-western corner pilaster (AFJ, July 31st 1963). From these statements, it was possible to determine the direction of the numbering of the pilasters on the walls of the building. Therefore, the pilaster that preceded the north-eastern corner pilaster on the eastern wall must have been pilaster 32. It was stated that opposite to pilaster 32, in the interior of the building, was pillar II, and on the opposite side, pillar IV (AFJ, August 12th 1963); thus, it can be concluded that the marking of pillars inside building C was carried out in exactly the same way as in building A (repeated as an identical duplicate of the arrangement, without symmetry reflected across the axis of the *forum*).

The archaeological journals also mention another important piece of information, namely, that the door through which building C communicated with area B was located in square 12, and that pilaster 29 was immediately next to the door (AFJ, July 16th 1963).

Square 10 abutted the western wall, and the context of an archaeological note indicated that one corner of its square was formed by pilaster 37 (AFJ, July 21st 1963). Square 13 and pilaster 39 abutted the western wall (AFJ, July 19th 1963). Squares 19 (AFJ, July 19th 1963) and 22 (AFJ, July 19th 1963) abutted the same wall. Therefore, squares 10, 13, 19 and 22 form a sequence that, according to their numbers, can be oriented in a north–south direction, abutting, at the same time, on the western wall.

It is stated that square 24 abutted the eastern wall of the building (AFJ, July 13th 1963), but also the southern and the western wall (AFJ, July 15th 1963). It is, therefore, obvious that there was an error in the notes, because due to the nature of the division of the interior space the square could not have abutted both the eastern and western wall at the same time. We get some clarification in the part where it was stated that square 24 abutted square 21 (AFJ, August 15th 1963); it was previously stated that it abutted the eastern wall of building C (AFJ, July 16th 1963). From there, it becomes clear that square 24 comprehended the south-eastern corner of the building.

By taking into account the position of squares 3 and 24, it becomes clear that the specified se-

quence of squares 10–13–19–22 in the western third of the building, according to this order, can only be oriented in a north to the south direction. At the same time, squares 3, 12, 21 and 24 belong to the sequence that abutted the eastern wall of building C. By comparing the markings of the squares in the previous two groups, it is noticeable that squares 22 and 24 were separated by the one square that could only be found in the central row, to which the door on the southern wall of the building would belong as well. At the same time, the squares on the northernmost side (along the northern wall) were marked with numbers from 1 to 3. By combining all the data on the square numbering of building C and comparing it with that of building A, we can see that they are the same.

At the same time, it becomes apparent that squares 10 and 13 are adjacent, so their previously mentioned corner pilasters 37 and 39 had to have been separated by the segment of the western wall with pilaster 38 in the middle of it. The mentioned direction and order of numbering are in agreement with the one already defined (taking into account the fact that the corner pilasters were not included in the numeration), which is only a confirmation of the correctness of the previous grid layout reconstruction procedure (**Figure 6**).

OLDER BUILDING UNDER BUILDING C

During the research of building C, near pilaster 33, a lower, older wall was registered, which, according to researchers, turned towards the east, forming a rectangular room, 1.50 m from the northern wall of the mentioned building (AFJ, July 31st 1963). Thus, it became clear that the foundations of an older building were located under the remains of building C.

The area of squares Ic and Id was opened to reveal the western wall of the temple and the more recent wall, going from the north-western corner of the temple to the north-eastern corner pilaster of building C. The intention of the researchers was also to determine the shape of the *prae-furni-um* discovered along the northern wall of the older building under building C. According to the researchers, the borders of the dugout were the mentioned wall of the temple, the more recent wall

that connected the mentioned corner of the temple and the corner of building C, and the eastern half of wall 5 (AFJ, August 20th 1963). Therefore, wall 5 actually represented the northern wall of the older building.

In the area of square IIIa, it was noted that the wall of the older building “still continues (in relation to squares IIIc, Va, Vc, Ve, where it was previously discovered), but now changes its direction slightly, becoming parallel to the wall of the temple” (AFJ, August 29th 1963). Judging by the mentioned context, it would seem that the breaking point of the wall belongs, at least partially, to this square. As for square IIIc, it was stated that “a smaller chamber was formed in this segment with two opposite walls” (August 29th 1963) (**Figure 6**).

In the part of the journal where the situation in the area of square Va was considered, it was indicated that more shallow pilasters appeared in places where the interior of the building was divided into smaller chambers. This circumstance introduces confusion because it is not clear whether these pilasters were located in the area of square Va or, as previously stated, in the area of square IIIc (adjacent to the former one) (AFJ, August 29th 1963) or in both of these squares. For the same segment, it was stated that the surface of the wall of the older building, which also extended through “square Ve”, appeared in the middle of the square (AFJ, August 28th 1963). This piece of information makes it easier for us to determine the length of the mentioned squares in the east–west direction. It was approximately twice as long as the distance of this wall from the eastern wall of building C. The specified length also fits with the previously defined axis in the north–south direction that divides squares III, V and VII into segments, and which coincides with the line of the axis of the pillars of the eastern portico of building C.

TEMPLE OF ANTINOUS (BUILDING D)

One of the major problems when citing certain archaeological discoveries in the area of the Temple of Antinous is the fact that their finding place was not precisely stated in the archaeological journals. That is why it is important to follow the chronology of the excavations along with the

area where they were conducted in a given period within the temple.

According to the notes in the archaeological journals from 1960, the first traces of the temple were found at the location of its northern wall (AFJ, July 23rd 1960). From this side to the south, the eastern and the western walls of the *cella* were excavated. The finding of a mortar floor is also linked to the same date, therefore, it is apparent that a part of the preserved floor was located next to the northern wall of the building. It is obvious that excavations were performed in the area of the *cella* (the central chamber of the temple) in the following days in order to reach the southern wall, but this goal was not reached until July 26th 1960. Segments of the floor continued to be found, which indicates that a part of the floor also extended through the central part of the *cella* (AFJ, July 25th 1960). The works on the northern wall of the *cella* were not finished, since from July 30th to August 3rd of the same year, the apse of the temple was discovered. It is very important to note that it was not until August 4th 1960 that the conclusion was reached that the northern wall continued to extend towards the east, leading, in turn, to the conclusion that only a part of the northern wall of the temple's *cella* was investigated in the previous period.

During 1961, a significant discovery occurred, namely, that of the stairs on the southern side of the building (they were excavated in squares IIIb, Iva and IVb). The first instance of determining the staircase occurred in the western part of square IVb, and, within the same square, the appearance of the eastern edge of this construction was registered (AFJ, June 26th 1961). It was also stated that the steps extend from square IVb, through IVa, further west (AFJ, June 27th 1961). During the next two days, it became clear that the previously investigated area of the *cella*, and the eastern wall of the eastern portico, together with the stairs, form one room, separated from area B and treated as a separate building D (according to AFJ, starting from August 29th 1961). The spatial layout of the squares on the southern part of the temple area was indicated by an archaeological note, dated August 30th 1961, where it was said that it was divided into 4 parts, according to the internal layout delimited by the walls, and that the distribution included the previous squares I and II, IIIa and IIIb, IVa and IVb.

From the same note, it becomes apparent that these parts were labelled with letters of the Greek alphabet. Also, space α was divided into two parts, $\alpha 1$ and $\alpha 2$, while spaces β and γ represent separate spatial units. For the last two areas, it was indicated that they were “analogous” to each other (AFJ, July 1st 1961). The only two spaces that could have had these features are the western and eastern porticos. The identification of space γ is aided by the note that “a slanting transverse wall cut through and destroyed the upper part of the western wall of space γ ”, which was obviously the more recent wall, extending from the north-western corner of the temple's portico to the north-eastern pilaster of building C. The identification of space $\alpha 1$ was indicated by the researchers' note that there were remnants of a brick floor on d152, which determined the level of the central space of the temple (AFJ, July 10th 1961). This finally determined the distribution of the researched area of the Temple of Antinous (**Figure 6**).

CONCLUSION

War-related, political and historical circumstances have contributed to a situation in which a large amount of data from the excavations of *Municipium* DD near Sočanica was lost, a part of the technical documentation included. Such was the case with the grid layout that the researchers constantly refer to in archaeological journals, and in the absence of which it is impossible to comprehend the context of any archaeological find. By analysing data from archaeological journals and the dissertation by Emil Čerškov, we have managed to decipher the numeration of the spatial, architectural and construction elements of the *forum* of this settlement. The topic of the marking of the squares with the use of a grid layout was particularly tackled, as well as the marking of the pilasters and the pillars.

During the deciphering of the numeration of the spatial and structural elements of each building, an individual approach was used. This approach had to be chosen because the grid did not always have a standardised or systematised marking system within each of the individual buildings and adjacent spaces (area B, the space inside the temple and the space north of the *horreum*). Thus, the squares inside buildings A and C were num-

bered with Arabic numerals, those inside area B with Roman numerals, while individual segments inside the temple were marked with letters of the Greek alphabet. The combination of these markings, without a restored grid layout, made it difficult for today's researcher to navigate through the archaeological journals.

Our analytical procedure for each individual building turned out to be the correct approach because in the case of buildings A and C, which are symmetrical to each other in relation to the axis of the *forum* rather than exact duplicates, an expected symmetrical numbering of their spatial and structural elements was not carried out by older researchers, instead, it was repeated in the same way in both buildings. A particularly demanding deciphering task was encountered in the case of area B, where the number of squares and their sizes differ, as well as the number of segments into which they were additionally divided. Errors were also observed during the numbering of certain building elements (pilasters on the western side of building A and the description of the borders of square 24 in building C), which were clarified by our analysis.

The analysis also determined the time period in which individual trenches were excavated. The positions of individual test trenches from 1959 have been reconstructed (although there are no preserved archaeological journals about these investigations), which preceded the systematic investigations in the later period. The interpretation of the chronology of the excavations will also contribute to a more precise understanding of the place where certain archaeological finds and architectural remains were discovered, both during the entire excavation period but also during an individual year. Such an interpretation has already brought results regarding the clarification of the finding place of certain architectural remains of the Temple of Antinous and the civilian basilica.

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REZIME

RESTITUCIJA KVADRATNE MREŽE NA PROSTORU FORUMA MUNICIPIJUMA DD

KLJUČNE REČI: REKONSTRUKCIJA TOKA ARHEOLOŠKIH ISTRAŽIVANJA, KVADRATNA MREŽA, METODOLOGIJA U ARHEOLOŠKIM ISTRAŽIVANJIMA, ARHEOLOŠKE CELINE, *FORUM, MUNICIPIUM DD, SOĆANICA*.

Poznate istorijske, ratne i političke okolnosti doprinele su da ostaci Municipijuma DD, jednog od antičkih naselja na prostoru severa Kosova i Metohije, budu zanemareni duže vremena, što je praćeno i nedostatkom određenog dela dokumentacije sa istraživanja. Ovakav problem vodi ka neminovnom nerazumevanju arheološkog konteksta u kome se došlo do pronalaska određenih arheoloških nalaza. Najveći problem po pitanju ovog lokaliteta odnosio se na nedostatak kvadratne mreže, prema kojoj su arheološka istraživanja bila

organizovana, a koja je prema sačuvanim arheološkim dnevnicima očigledno postojala. Kako bi se mnogo bolje razumeo arheološki kontekst, neophodno je bilo restituisati njene pravce na prostoru foruma Municipijuma DD.

Kvadratna mreža nije uvek imala standardizovano ili sistematizovano označavanje unutar svakog pojedinačnog objekta i njemu susednih prostora. Kvadrati u objektima A i C numerisani su arapskim brojevima, na prostoru B rimskim, dok su unutar hrama njegovi pojedinačni prostori imenovani slovima grčkog alfabeta. Za današnjeg istraživača, bez raspoložive restituisane kvadratne mreže, kombinovanje navedenih oznaka otežava snalaženje u arheološkim dnevnicima. Odgonetanju nabiranja prostornih i konstruktivnih elemenata svakog objekta pristupljeno je zato pojedinačno. Ovakav postupak analize pokazao se ispravnim kod objekata A i C, koji su u odnosu na osu foruma inače simetrični jedan drugom, ali u isto vreme nije izvedena simetrična numeracija njihovih prostornih i konstruktivnih elemenata, već identična. Uočene su i greške prilikom numeracije pojedinih elemenata građevina koje su našom analizom razjašnjene (kod pilastera građevine A i opis kvadrata 24 u građevini C). Naročito zahtevno odgonetanje nabiranja bilo je na prostoru B čiji se broj kvadrata i njihove veličine razlikuju, kao i broj segmenata na koji je svaki od njih dodatno podeljen.

Našom analizom razjašnjeno je i u kom vremenskom periodu su izvedene pojedine sonde. Tumačenje hronologije iskopavanja doprineće i preciznijem tumačenju mesta na kome su pronađeni pojedini arheološki nalazi i arhitektonski ostaci, kako u toku celog procesa istraživanja, tako i tokom samo jedne kampanje u kalendarskoj godini.

* * *

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FROM PASSION TO SCIENCE: INSIGHT INTO THE HISTORY AND PRESENT STATE OF PIGEON-RELATED ARTIFACTS PRESERVED IN THE NIKOLA TESLA MUSEUM

ABSTRACT

*Among the numerous artifacts, i.e., archival documents, monographs, serial publications, newspaper clippings, and personal and technical items, preserved in the Nikola Tesla Museum in Belgrade, there are two letters and three samples of pigeon supplements, sent to the famous scientist, engineer, and inventor, at his request, by the Philadelphia Seed Co. (Philadelphia, U.S.A.) in late 1937 and early 1938. The principal aim of the research was to (1) analyse the written sources and published literature that bring us closer to an understanding of his relationship with pigeons, among which are the previously mentioned documents of the correspondence; (2) investigate the physicochemical properties of the artifacts; and (3) perform microbiological analysis in order to determine the degree of contamination and to issue recommendations for their further housing in the museum if needed. Research has yielded new and interesting facts, almost unknown to date, from the famous scientist's life. Furthermore, it showed the nature of the investigated supplements: mineral hematite (T:27.35) and charcoal of various granulations (T:27.39; and T:27.40) and demonstrated the good condition of the preserved artifacts, with the degree of microbial contamination ranging from 1.5 to 4.0, and CFU g⁻¹ from 3.85 to 214.29. The only documented contaminants are beneficial bacteria of the genus *Bacillus*, while moulds and pathogenic microorganisms in general were absent.*

KEYWORDS: CHARCOAL, CONTAMINATION, CORRESPONDENCE, HEMATITE, MICROORGANISMS, NIKOLA TESLA, MUSEUM, PIGEONS, PRESERVATION, SUPPLEMENTS.

INTRODUCTION

Nikola Tesla (Smiljan, July 10th, 1856 – New York, January 7th, 1943), was an American scientist of Serbian origin, who contributed to sci-

ence and the technical and technological progress of human civilization, mostly as the inventor of the rotating magnetic field, induction motor, polyphase alternating current and the complete system of production, distribution and use of

electricity. He constructed a generator of high-frequency currents and voltages, known today as the Tesla transformer, coreless transformer or Tesla coil. A long list of 311 patents in total, registered in 27 countries, is testimony to his vision and creativity, but also to his dedication to scientific research in the most diverse fields – from energy, radio engineering, wireless control, lighting technology, mechanical engineering and aviation, to the application of high-frequency and high-voltage electricity in industry and medicine (Маринчић 2006; Циврић и Стојиљковић 2006). Like every great man, Nikola Tesla has his own oeuvre, but also an authentic life, interesting and intriguing for numerous researchers of the most diverse professions and orientations – from historians of science, electrical and mechanical engineers, computer scientists, telecommunications, aviation, and military experts, to medical experts, psychologists, ecologists and philosophers.

The great creators' legacy is a precious, authentic testimony about them and their works. It is a kind of source and an undoubted incentive for numerous researchers to penetrate the secrecy of their lives and, thus, discover their wishes, aspirations and achievements. Thanks to Tesla's careful preservation, despite the frequent changes in the locations where he lived and created, his legacy still exists, housed in the Nikola Tesla Museum¹ in Belgrade. The legacy is a unique entity consisting of archival documents, museum exhibits (personal and technical items), and library materials (monographs, serial publications, and newspaper clippings). It is kept, processed, and studied within the three collections of the Museum: Archive, Collective Fund, and Library. The most significant part of the fund is certainly the Tesla archive with over 156,000 documents – a historical testimony of his life and work, but also a first-class source,

not only for the history of the technical and technological development of society from the end of the 19th and the first half of the 20th century, but also for the study of the contemporary lifestyle in the U.S.A. and Europe.

The Collective Fund of the Nikola Tesla Museum consists of nine collections with over 1,200 artifacts. The collection contains original technical items from the field of mechanical and electrical engineering, Nikola Tesla's personal and clothing items, medals and decorations he received, as well as fine and applied art items from his legacy.

The three objects from the legacy – samples of pigeon supplements – are not the result of his work and creativity, nor devices, parts of equipment, or materials used in his numerous pieces of laboratory research, but indisputable material evidence of his concern for the health of pigeons: "Venetian Red", "Charcoal No. 6", and "Charcoal No. 10", obtained by Nikola Tesla from the Philadelphia Seed Co. Since these artifacts have not been researched until now, the Nikola Tesla Museum and the Faculty of Biology, University of Belgrade took a joint step into this research with two main goals. The first was to present a part of Tesla's legacy for the first time and, therefore, new and interesting details from his life and work, while the second was to offer recommendations for better storage and preservation of these original artifacts in the future, if needed. In order to realize these goals, it was necessary to analyse and define the cooperation denominators between Nikola Tesla and the Philadelphia Seed Co. (archival documents – letters of correspondence), examine the physicochemical properties of the pigeon supplement artifacts, and determine the degree of microbial contamination.

DESCRIPTION OF THE PRESERVED ARTIFACTS

The archive of Nikola Tesla contains two original letters, sent to him by the employees of the Philadelphia Seed Co. in the U.S.A. (**Figure 1**). The content of the letters is of a business nature. No corresponding envelopes were preserved. The first document – a letter from Joseph B. Hertzfeld, director of the Food Department of the Philadelphia Seed Co. – was sent to Nikola Tesla at the New Yorker Hotel on November 22nd, 1937. In

¹ The Nikola Tesla Museum is a unique institution of science and culture and is entirely dedicated to the famous scientist, engineer, and inventor. It was founded by the decision of the Government of the Socialist Federal Republic of Yugoslavia on December 5th, 1952, and opened to the public on October 20th, 1955. The former family villa of the politician and industrialist Đorđe Genčić, located in Krunska Street, in the very centre of Belgrade, was designated as the Nikola Tesla Museum building. This representative building, built in 1929 according to the project of the famous Serbian architect Dragiša Brašovan, was declared a cultural monument in 1987.

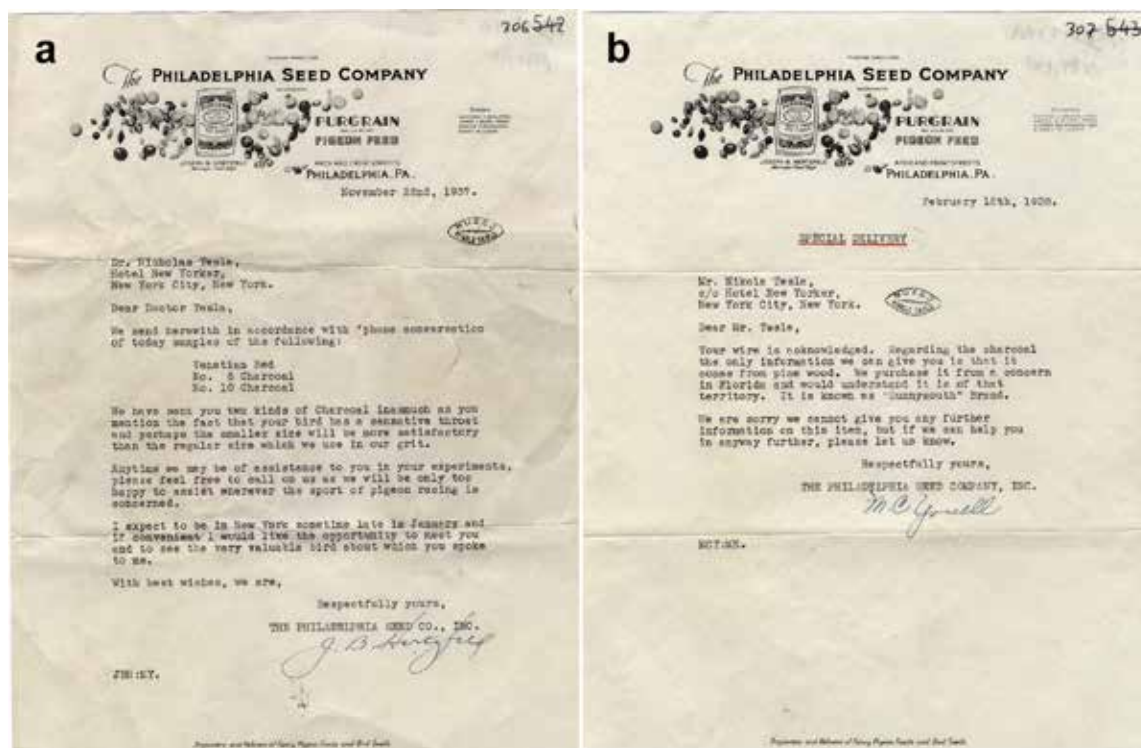


Figure 1. Letters of correspondence between Nikola Tesla and the representatives of the Philadelphia Seed Co.: a. Joseph B. Hertzfeld, November 22nd 1937; b. M.C. Yonell, February 12th 1938 (from Nikola Tesla Legacy, Nikola Tesla Museum, Belgrade).

the letter, Herzfeld pointed out that, in accordance with their telephone conversation, he was sending three samples of pigeon supplements, offered help with Tesla's experiments and everything related to pigeon racing, and then emphasised that he would come to New York at the end of the following January and use the opportunity to meet Tesla and see his "precious bird" (Nikola Tesla Legacy, MNT, LXI, 306A). The second letter was a response to Tesla's telegram, from M.C. Yonell, one of the Philadelphia Seed Co. employees, on February 12th, 1938, and contained details about the origin of the supplements and detailed Yonell's willingness to help Tesla with anything else that might be required (Nikola Tesla Legacy, MNT, LXI, 307A).

Three samples of pigeon supplements, delivered to Tesla's New York hotel at the end of 1937, are kept in the Collective Fund of the Nikola Tesla Museum, specifically in the collection of items from the field of chemical technology² (numbered

T:27.35; T:27.39; and T:27.40) (**Figure 2**). The supplements are packed in specially made paper bags (83.27 [W] x 202.00 [L] mm). They are folded in half, which ensures that the supplements cannot be scattered. When the upper part of the bags are folded, their dimensions are 83.27 [W] x 100.45 [L] mm. In the mid-top section of the folded part (lid), a semi-circular part is cut, so that the bags can be opened more easily. On the lower front parts of the bags, the name and address of the store is printed: The Philadelphia Seed Co. (Incorporated), Arch and Front Streets, Philadelphia, Pa., U.S.A. On the same side, typed, are the supplement names ["Venetian Red" (T:27.35); "Charcoal No. 6" (T:27.39); "Charcoal No. 10" (T:27.40)], underlined in red.

anodized aluminium, zirconium, chromium, lead), three metal vessels, 2 graphite vessels for melting metals (one incomplete), two zirconium vessels, 5 wooden boxes with glass vials containing fine oil for lubricating chronometers, powder samples (charcoal, mineral hematite), several samples of steel, nickel, and silver wires and rods, as well as analytical scale with an associated set of weights.

² Collections of items from the field of chemical technology consist of 60 different museum artifacts, namely: 24 metal samples (copper, iron, steel, nickel, aluminium,



Figure 2. Samples of pigeon supplements kept in the Collective Fund of the Nikola Tesla Museum: a. “Venetian Red” (T:27.35); b. “Charcoal No. 6” (T:27.39); c. “Charcoal No. 10” (T:27.40) (from Nikola Tesla Legacy, Nikola Tesla Museum, Belgrade).

MATERIALS AND METHODS

Characterisation of the supplements

Raman spectroscopy

The analysed samples were pulverised in an agate mortar, tableted using a hand press, and spectra were collected using a Thermo Scientific DXR Raman spectroscope coupled with an Olympus confocal microscope with a 50x objective lens. The spectroscope was equipped with a 780 nm solid state laser. The acquisition time was 50 s. The spectrum was obtained from the surface of the tableted sample and OMNIC Spectra Software (Thermo Scientific) was used for processing the spectra. Identification was carried out by comparing the obtained spectra with reference spectra of different carbon sources.

Stereomicroscopic observations

The morphology of the pigeon supplements was analysed using a Nikon SMZ 745T stereo microscope equipped with a Dual Sight 1000 camera.

Scanning electron microscopy and energy-dispersive X-ray spectroscopy

For the scanning electron microscopy with energy-dispersive X-ray spectroscopy, the analysed supplements were put on adhesive carbon

tape on aluminium cylinders. The images and spectra were obtained at the University of Belgrade—Faculty of Mining and Geology, using a JEOL JSM–6610LV microscope coupled with an X-Max energy dispersive spectrometer. The samples were gold coated ($d = 15 \text{ nm}$, $\rho = 19.2 \text{ g/cm}^3$) using a Leica EM SCD005 sputter coater. Secondary electron and backscattered electron images were obtained using a W-filament gun, at 20 kV acceleration voltage in high-vacuum mode ($15\text{--}30 \text{ }\mu\text{Pa}$ of pressure in the sample chamber) and with magnifications ranging from 150 to 30,000 \times .

Determination of the degree of contamination

ATP bioluminescence method

To assess, in situ, the degree of total contamination of the studied artifacts, with microorganisms and organic residues, the ATP bioluminescence method was applied (Unković *et al.*, 2019). For this, ATP swabs and the Lightning MVP portable luminometer (BioControl Systems) were used on all artifacts. The results were compared to the manufacturer’s provided reference scale and placed in one of the three categories of contamination (*zone of cleanliness*): clean zone (0.0–2.5); caution zone (2.5–3.0); and danger zone (3.0–7.5).

Isolation and identification of microorganisms

Sampling for microbiological analysis was conducted on April 4th, 2020, using sterile cotton

swabs. In laboratory conditions, samples were diluted in 10 ml of sterile dH_2O and agitated mechanically for 10 min, after which 1 ml of the resulting aliquot was inoculated on a general growth medium, Malt Extract Agar (MEA), recommended for the detection, isolation and enumeration of fungi, particularly yeasts and moulds, as well as bacteria, in various materials. The inoculated plates were incubated at 25 ± 2 °C. After an incubation period of 7 days, the plates were analysed and isolated microorganisms were identified on the basis of colony morphology. The grown colonies were also counted and the results were expressed as Colony Forming Units per gram of sample (CFU g^{-1}).

RESULTS AND DISCUSSION

Historical background of the artifacts

Nikola Tesla published six autobiographical articles in the magazine “Electrical Experimenter”, from February to October 1919. He wanted to present events from his life in an interesting way in a renowned and very popular American magazine and, thus, pique the interest of the young generation in science and scientific-technical research. In the March issue of the magazine, he presented an interesting detail from his earliest childhood. It was related to the relocation of his family from the village of Smiljan to the nearby town of Gospić. Of this, he says: *“It almost broke my heart to part from our pigeons, chickens and sheep, and our magnificent flock of geese which used to rise to the clouds in the morning and return from the feeding grounds at sundown in battle formation, so perfect that it would have put a squadron of the best aviators of the present day to shame”* (Tesla 1919: 843).

As a boy, Tesla enjoyed feeding pigeons, and chickens and other poultry, taking them in his arms, and hugging and caressing them. In a letter addressed to Pola Fotić, the daughter of Konstantin Fotić (1891–1959), he stated that, from time to time, he played in the poultry yard. There were days, says Tesla, *when “our geese, led by the gander, rose high in the air and flew down to the meadow and brook where they sported like swans in the water and probably found some food. I would then feed and pet the pigeons, the poultry*

and our grand resplendant [sic] cock, who liked me. In the evening, the gander brought back his flock, who made a few turns above the house and then came down with a deafening noise. The sight of the flying geese was a joy and inspiration to see.” (Tesla 1939)

One could say that the love and care of animals were exalted feelings that Tesla took with him from his native Smiljan and that he would express regularly in the latter part of his life, especially with regard to pigeons. He did this in various ways: by feeding flocks of pigeons in public places (New York Public Library Square on 42nd Street and St. Patrick’s Cathedral Square on 50th Street), by keeping and feeding the birds in his hotel room, but also by his selfless care for their wellbeing when they were sick.

John Joseph O’Neill (1889–1953), in his book “Prodigal Genius: The Life of Nikola Tesla” presented several interesting details from the scientist’s life related to feeding and caring for pigeons. He says: *“When he [Tesla] appeared and sounded a low whistle, the blue, brown and white-feathered flocks would appear from all directions, carpet the walks in front of him and even perch upon him while he scattered bird seed or permitted them to feed from his hand.”* (O’Neill 1944: 307–308)

On a given day each week, Tesla would have one of his secretaries buy three pounds each of rape, hemp, and canary seeds, and then they would mix them all. Every day the scientist would take a paper bag, fill it with seeds, and go to feed the pigeons. In addition to feeding the birds in the street, Tesla also kept them in his hotel rooms. He had baskets for up to four pigeons, and a big bowl of seed nearby.

One day in 1921, Tesla became seriously ill in his office on 40th Street. As the symptoms became more severe, he realised that he would not be able to return to his room in the St. Regis Hotel. He called the secretary and gave her precise instructions on what needed to be done. She was to call the hotel, find the maid on the 14th floor, and convey Tesla’s message to her to feed the dove that day – “a white female with grey wings” – and to do so regularly until further notice. A few months later, O’Neill said, Tesla did not show up at the office one morning. He stayed in the room because he had to take care of his sick dove. For the next few days, he did not come to work (O’Neill 1944: 309–311).

This activity caused numerous misunderstandings with the hotel management and staff. Of this O'Neill writes: "*Great flocks of them [pigeons] would come to his windows and into his rooms, and their dirt on the outside of the building became a problem to [sic] the management and on the inside to [sic] the maids.*" The scientist tried to solve the problem by putting the birds in a large basket and moving them to his close associate's estate outside of New York. However, as soon as the birds were released, they would immediately return to the hotel. The hotel management made it clear to Tesla – he would either have to stop feeding them or move out. He moved out. After that, he lived in the "Pennsylvania" hotel and the "Governor Clinton" hotel, but, unfortunately, the outcome was the same in both. From 1933, he lived in the "New Yorker" hotel, where he spent the last years of his life (O'Neill 1944: 312–313).

Sava Kosanović (1894–1956), the youngest son of Tesla's sister Marica, also wrote about the fact that the scientist used to feed the pigeons. In his text entitled "With Nikola Tesla", Kosanović states: "*After dinner, Tesla takes the already prepared bag of pigeon food and goes for a walk. In front of the magnificent building of the Public Library, on Fifth Avenue, Tesla scatters the food to the pigeons, who gather there, like in St. Mark's Square in Venice. It is his favorite pastime and leisure. Entertainment imbued with feelings.*" (Косановић 1927: 4)

Another interesting event related to this activity was described by John O'Neill. He stated that in 1916, Tesla was awarded the Edison Medal.³ However, a few moments before the award ceremony at the Engineers' Club in May 1917, the celebrant disappeared. Bernard Arthur Behrend (1875–1932), chairman of the Edison Medal Executive Committee, noticed that the celebrant, before leaving the room, fed the pigeons and put a paper bag in the pocket of his formal suit. Beh-

rend realised what was happening and rushed out to the nearby Bryant Park library, only to witness an amazing site:

"*In the center of a large thin circle of observers stood the imposing figure of Tesla, wearing a crown of two pigeons on his head, his shoulders and arms festooned with a dozen more... On either of his outstretched hands was another bird, while seemingly hundreds more made a living carpet on the ground in front of him, hopping about and pecking at the bird seed he had been scattering.*" (O'Neill 1944: 231–235)

In the text of the article entitled "Dr Tesla Gives Home to an Errant Pigeon That Flew Into 40th-Storey Room in Hotel", published in the *New York Times* on February 6th, 1935, it was stated that the previous day, a maid on the 40th floor of the New Yorker hotel had telephoned the management to say that she had found a carrier pigeon in one of the vacant rooms. While the management was trying to solve the problem, the maid mentioned it to Nikola Tesla since she knew from experience that Tesla loved pigeons and would be able to help them. Since he already kept one convalescent pigeon in his room, he pointed out that the two could keep each other company. He examined the bird and concluded that it was not sick, but hungry and a little upset, because, in the absence of anything edible, it had eaten snow. (Anon. 1935).

Two years later, on May 1st, 1937, the *New York Times* published a related article. The text entitled "Tesla Is Provider of Pigeon Relief" confirms that Tesla was still taking care of the pigeons, though not personally. The previous autumn he had hired a young Western Union messenger named John Lucan to feed the birds in Bryant Park twice a day. Lucan also took care of the sick birds and made sure they had enough water during the winter, when the fountains are dry. The journalist stated that the scientist had been interested in pigeons for seventy-five years, since his earliest childhood in his native village of Smiljan (Anon. 1937).

Analyses of the artifacts

In order to examine the present state of the pigeon supplements kept in the Collective Fund of the Nikola Tesla Museum, their physicochemical properties, as well as the total degree of microbial contamination, were determined.

³ The Edison Medal was established by a group of friends, associates, and admirers of the great scientist and inventor Thomas Alva Edison (1847–1931), at the American Institute of Electrical Engineers (AIEE). It was established on his 57th birthday, February 11, 1904, to commemorate the 25th anniversary of the successful introduction and commercial development of the incandescent lamp he had invented. The award is given for achievements in the field of electrical science.

Physicochemical properties of the artifacts

The mass of the studied artifacts, both the total and that of the supplements alone, as well as their chemical composition, are summarised in **Table 1**. Raman analysis of the chemical composition of supplements has shown that the “Venetian Red”

cording to the letter that Nikola Tesla received from the seller, both charcoal samples (1) were obtained by processing pine wood growing in the area of Florida (“*the only information we can give you is that it comes from pine wood*”) (Nikola Tesla Legacy, MNT, LXI, 307A), (2) are smaller than the regular grain size, and (3) are suitable for birds

Artifact code	Mass (g)		Chemical composition
	paper bag + supplement	supplement	
T:27.35	35.4891	30.7853	hematite ($\alpha\text{-Fe}_2\text{O}_3$)
T:27.39	5.5429	1.3184	charcoal (C)
T:27.40	14.9062	10.6575	charcoal (C)

Table 1. Mass (g) and chemical composition of pigeon supplements kept in the Collective Fund of the Nikola Tesla Museum

supplement (T:27.35) is an iron oxide with a trace of chalk, i.e., the mineral known as hematite ($\alpha\text{-Fe}_2\text{O}_3$) (**Figure 3a**). At the same time, both “Charcoal No. 6” (T:27.39) and “Charcoal No. 10” (T:27.40) are derived from charcoal (**Figures 3b and 3c**) and are the same type of supplement but of a different granulation (**Figure 4**). These findings were further supported by scanning electron microscopy and energy-dispersive X-ray spectroscopy, which not only gave an insight into the finer details of the supplements’ morphology, but also confirmed their chemical composition. Both “Charcoal No. 6” and “Charcoal No. 10” were shown to be composed of C and O, with miniscule impurities of Ca and K, while “Venetian Red” is composed of O and Fe, with admixtures of Ca, S and C (**Figure 5**). Further analysis of the supplements’ morphology, observed under the lens of the stereo microscope, has demonstrated that “Charcoal No. 6” is composed of rough-surface grains of mostly uniform size, while “Charcoal No. 10” demonstrates a variety of shapes, of unequal size and surfaces ranging from rough to glassy. Ac-

with sensitive throats (“*as you mention the fact that your bird has a sensitive throat and perhaps the smaller size will be more satisfactory than the regular size, which we use in our grit*”) (Nikola Tesla Legacy, MNT, LXI, 306A).

Present state of the artifacts

Analysis of the microbial contamination demonstrated a “very pale microbial print”, which indicates the good condition of the preserved pigeon supplements, with the degree of microbial contamination in the range of from 1.5 to 4.0, and CFU g^{-1} in the range of from 3.85 to 214.29 (**Table 2**). Supplement T: 27.35, i.e., “Venetian Red”, was in the best condition, with a zone of cleanliness value of 1.5 (clean zone) and a mean CFU g^{-1} of 3.85. In all three cases, the only documented contaminants are beneficial (good) bacteria of the genus *Bacillus*, with a total absence of pathogenic and detriogenic microorganisms (**Figure 6**). It is very indicative that filamentous micromycetes (moulds) were not detected in any of the analysed

Artifact code	Zone of cleanliness	CFU g^{-1}	Isolated microorganisms
T: 27.35	1.5 (clean zone)	3.85	Bacteria
T: 27.39	2.8 (caution zone)	214.29	Bacteria
T: 27.40	4.0 (caution zone)	16.66	Bacteria

Table 2. Degree of microbial contamination of pigeon supplements kept in the Collective Fund of the Nikola Tesla Museum

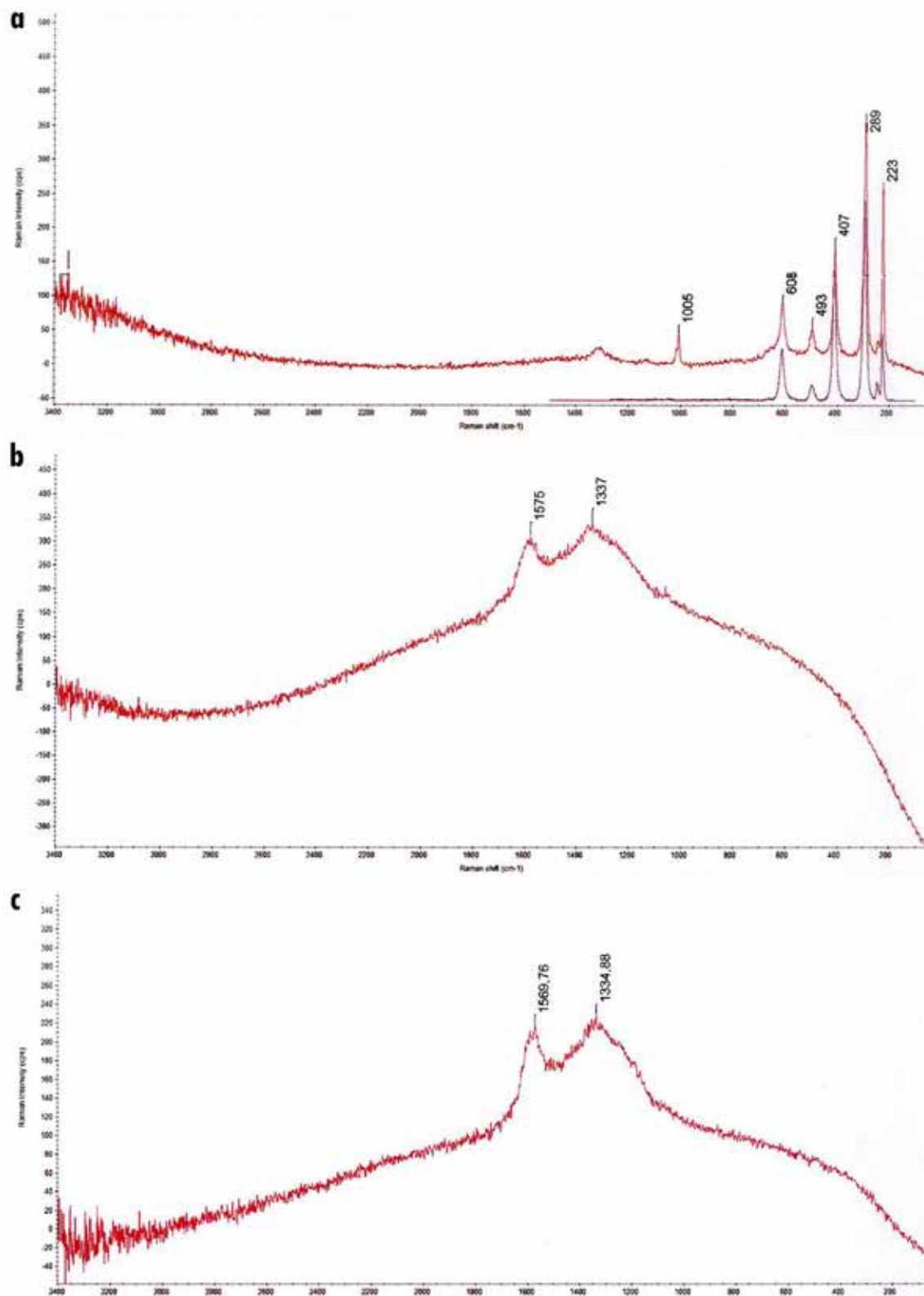


Figure 3. Raman spectroscopic analysis of pigeon supplements kept in the Collective Fund of the Nikola Tesla Museum: a. "Venetian Red" (T:27.35) – hematite; b. "Charcoal No. 6" (T:27.39) – carbon; c. "Charcoal No. 10" (T:27.40) – carbon.



Figure 4. Morphology of pigeon supplements kept in the Collective Fund of the Nikola Tesla Museum, observed under a stereo microscope: a. “Venetian Red” (T:27.35); b. “Charcoal No. 6” (T:27.39); c. “Charcoal No. 10” (T:27.40).

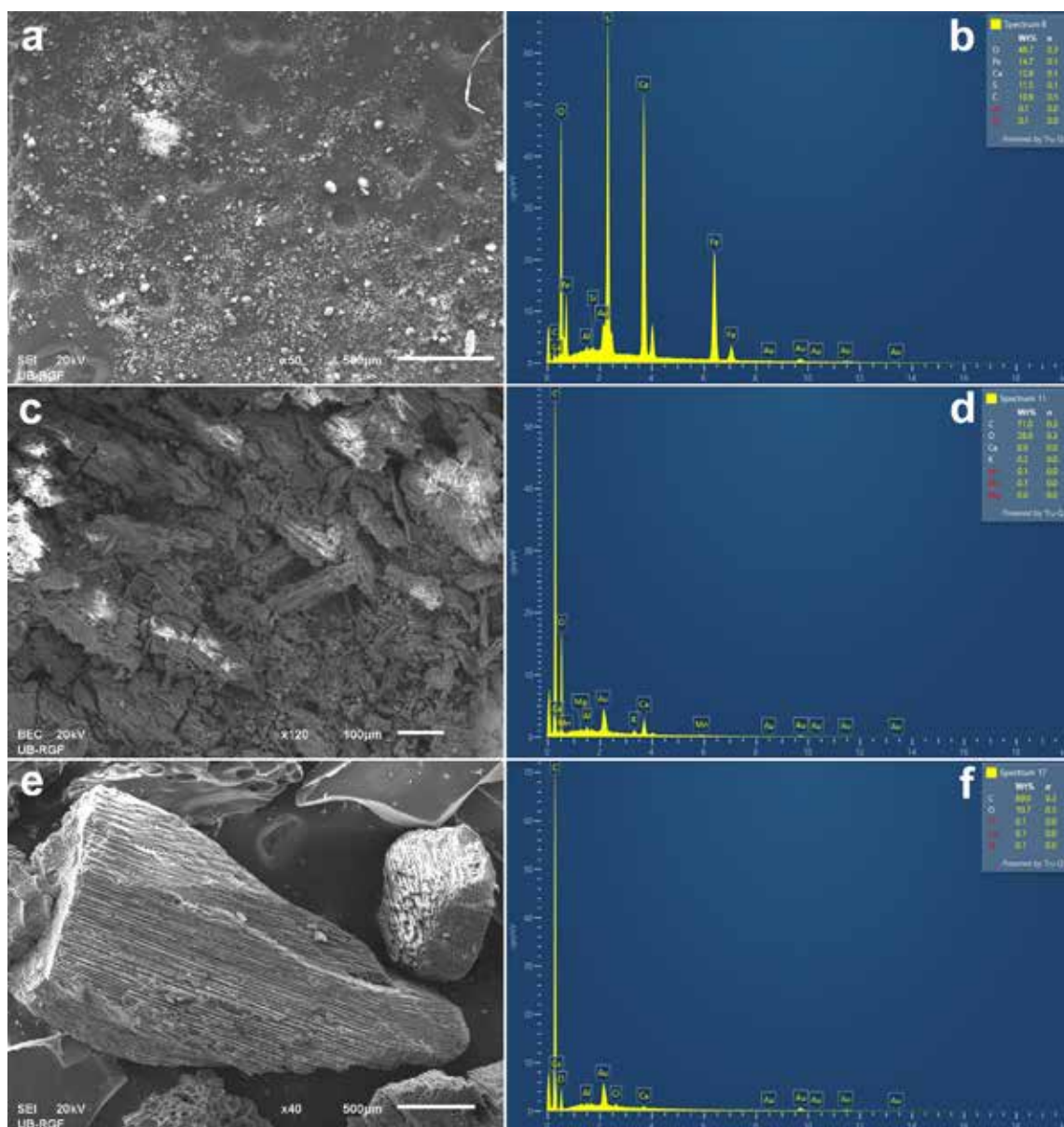


Figure 5. Morphology and chemical composition of pigeon supplements kept in the Collective Fund of the Nikola Tesla Museum, analysed with scanning electron microscopy coupled with energy-dispersive X-ray spectroscopy: a, b. “Venetian Red” (T:27.35); c, d. “Charcoal No. 6” (T:27.39); e, f. “Charcoal No. 10” (T:27.40).

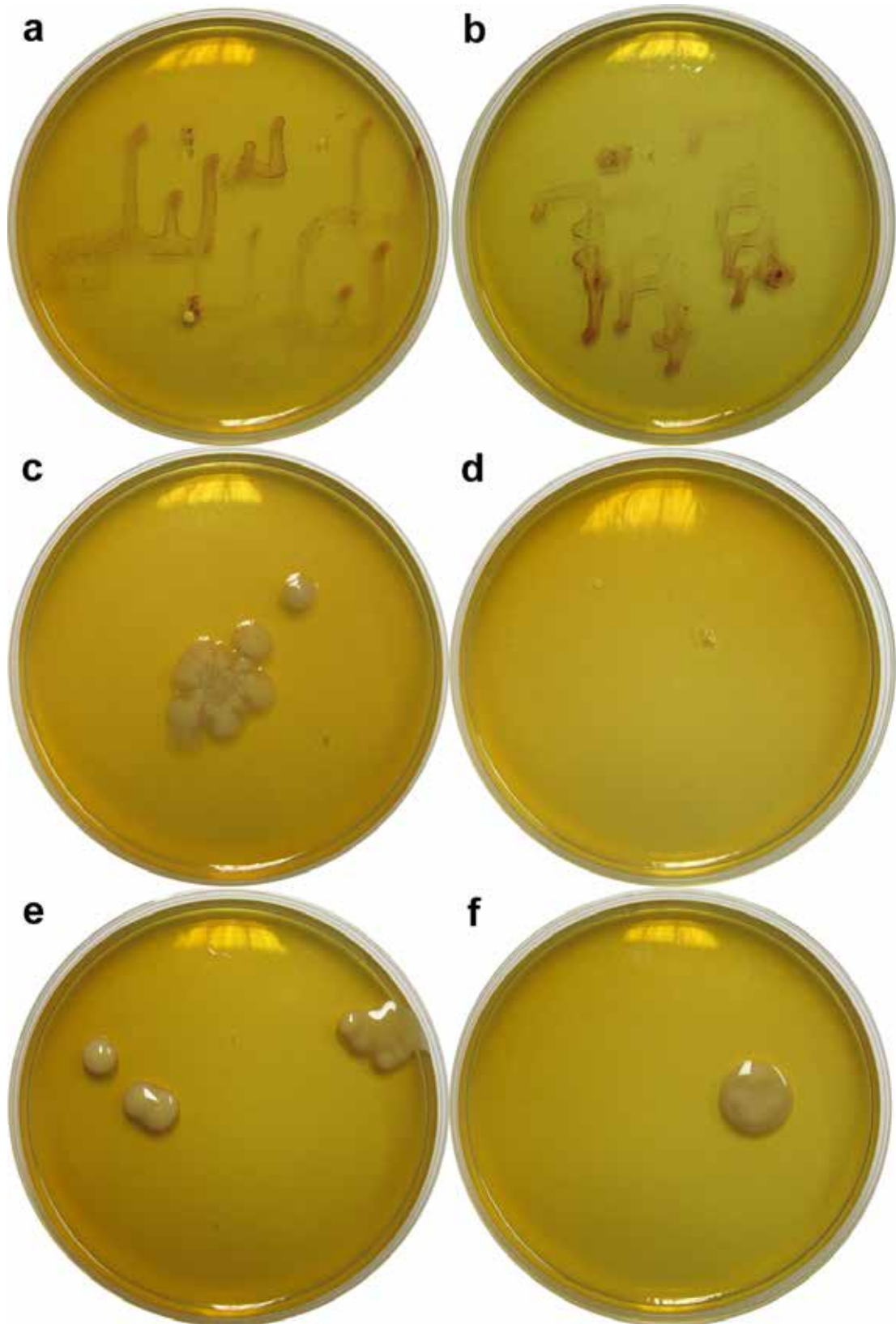


Figure 6. Microbial contamination of pigeon supplements kept in the Collective Fund of the Nikola Tesla Museum, observed under a stereo microscope: a, b. “Venetian Red” (T:27.35); c, d. “Charcoal No. 6” (T:27.39); e, f. “Charcoal No. 10” (T:27.40).

supplements. It is even more surprising that the supplements Nikola Tesla fed to the pigeons are almost sterile, even today, after nearly a century since their production.

CONCLUSION

Tesla was an enigma during his lifetime. Neither his close friends nor acquaintances could boast of either knowing or being able to explain him well. At the very least, a man who did not live like all the other people of the era was the subject of particular interest, and sometimes ridicule and disbelief. Numerous legends circulated about him, and when not always having enough material to determine his true character, human curiosity sometimes tried to construct it using various fragments, insufficiently verified, sometimes inaccurate, grouping them according to their own beliefs and perspectives. It is little wonder that the image formed in this way was inappropriate and, very often, wrong. For the sake of truth, the data about his personality need to be researched, systematised, and clearly presented to the scientific and professional community, as well as to the general public.

Based on the preserved documents of the correspondence between Nikola Tesla and the Philadelphia Seed Co., as well as numerous other analysed literature sources and paper clippings, it is quite clear that the famous scientist had a pronounced passion for pigeons and other birds, which entailed tender care for their wellbeing and a healthy diet. This care is not only seen in his nurturing behaviour towards pigeons but is also reflected in the chemical composition of analysed supplements he ordered from the Philadelphia Seed Co., i.e., hematite and charcoal, which presumably acted as a source of iron and assisted in the removal of toxins in pigeons.

Over the course of his rich scientific, engineering and inventing career, Nikola Tesla received 116 basic patents, with which he protected a total of 125 of his inventions. The remaining 195 patents represent their analogues. It is very interesting for our research that his last activity related to the protection of industrial property came on June 23rd, 1938, when he submitted his only trademark application, with which he protected a special type of food for poultry. The name of his food was

“Factor Auctus” - “growth factor”. The US Patent Office registered the trademark under number 372,906 on November 21st, 1939 (Šarboh 2007: 104).⁴ The reason for this work in a new field was probably his long-term concern for pigeons, but also his curiosity about many scientific fields, something that was also visible in his correspondence with the Philadelphia Seed Co. regarding his interest in the origin of the pigeon supplements.

Nowadays, although almost a century old, pigeon supplements presented in this paper and kept in the Collective Fund of the Nikola Tesla Museum, are still practically sterile, which indicates decades of responsible and professional care for the wellbeing of artifacts in Tesla’s legacy, which should continue unchanged in the future.

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REZIME

OD STRASTI DO NAUKE: ISTORIJA I STANJE ARTEFAKATA POVEZANIH SA GOLUBOVIMA IZ TESLINE ZAOSTAVŠTINE U MUZEJU NIKOLE TESLE

KLJUČNE REČI: DRVENI UGALJ, KONTAMINACIJA, PREPISKA, HEMATIT, MIKROORGANIZMI, NIKOLA TESLA, MUZEJ, GOLUBOVI, ČUVANJE, SUPLEMENTI.

Među mnogobrojnim artefaktima (arhivska dokumenta, monografske i serijske publikacije, novinski isecci, lični i tehnički predmeti) koji se čuvaju u Muzeju Nikole Tesle u Beogradu, nalaze se dva pisma, kao i tri uzorka suplemenata za golubove koje je čuvenom naučniku, inženjeru i pronalazaču, na njegov zahtev, poslala Filadelfijska semenara (država Pensilvanija) krajem 1937. i početkom 1938. godine. Ciljevi ovog istraživanja bili su: (1) analiza pisanih izvora i literature koji nam govore o Teslinoj ljubavi prema golubovima, među kojima su i napred pomenuta dokumenta prepiske; (2) utvrđivanje fizičko-hemijskih svojstava suplemenata za golubove iz Tesline zaostavštine; i (3) sprovođenje mikrobiološke analize u cilju procene stepena kontaminacije, i u skladu s rezultatima izdavanje preporuke za njihov smeštaj i dalje čuvanje. Istraživanje je pružilo interesantne detalje iz Teslinog života i rada. Određen je hemijski sastav suplemenata: mineral hematit (T:27.35) i drveni ugalj različitog stepena granulacije (T:27.39 i T:27.40), i konstatovano dobro stanje sačuvanih artefakata, sa procenjenim stepenom kontaminacije u opsegu od 1.5 do 4.0 i CFU g⁻¹ u opsegu od 3.85 do 214.29. Jedini zabeleženi kontaminanti uzoraka bile su dobre bakterije roda *Bacillus*, dok plesni i generalno patogeni mikroorganizmi nisu zabeleženi, što je pokazalo da su predmeti tokom proteklih decenija bili pod profesionalnom brigom stručnjaka Muzeja Nikole Tesle u Beogradu i da za sada nije potrebno izdavati dodatne preporuke za njihovo dalje čuvanje.

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ILLICIT TRAFFICKING OF CULTURAL OBJECTS BY FORCED MIGRANTS

ABSTRACT

Some sellers and buyers in global centres of trading and consumption of art and antiquities try to change attitudes towards cultural goods from zones of conflict and crisis by asserting that many or most have been transferred by refugees. Some law enforcement agents and humanitarian aid workers deny that there is any evidence of such flows. With a primary focus on the people who are involved rather than the objects that are handled, through open-source research, this paper documents more than a century of cases of illegal appropriation (through looting or theft), export and trading of cultural objects by internally displaced persons and externally displaced persons, who have been forced to leave environments of oppression, genocide, war, terrorism and economic-environmental degradation in Latin America, Africa, Asia and Europe, and who are forced to engage in subsistence crime. Due to a range of factors that are considered under the limitations of the evidence, little of the material relates to events in Europe in the 20th century.

However, this is being discussed at a time when the management of migration and the policing of crime are being merged into a policing of “crimmigration”. So, this paper challenges the risky perceptions among market actors that legal collections are significant sources and that refugees with legal or illegal collections are significant actors. Purchases of undocumented antiquities are more likely to finance violent political organisations. Law enforcement agencies and migration management agencies should adapt by protecting subsistence criminals and mobilising their intelligence against the violent political organisations that are driving displacement.

KEYWORDS: ANTIQUITIES LOOTING, ANTIQUITIES TRAFFICKING, CRIMMIGRATION, CULTURAL PROPERTY CRIME, FORCED MIGRATION, ILLICIT TRAFFICKING OF CULTURAL OBJECTS, SUBSISTENCE CRIME, SUBSISTENCE LOOTING, SUBSISTENCE TRAFFICKING.

INTRODUCTION

Around the height of international concern with the security crisis in the Arab world, a ‘topical question’ was posed in a discussion of how Nordic countries could collaborate to stop illegal trafficking of cultural objects. The Nordic Liaison Officer in Bulgaria and Romania for Nordic Police and Customs Cooperation wondered ‘whether the influx of refugees also [brought] along a flux of cultural objects’ (Ervik 2017: 44).

A contemporary study for the War Crimes Unit of the Dutch National Police did not present any foundational evidence, yet believed that it was ‘likely’ that some ‘refugees use[d]’ illicit antiquities, like any other accessible assets, ‘to finance their journey’ (van Lit 2016: 65). Similarly, financial crime risk management consultants did not cite any corroborating source, yet advised that ‘refugees of war may also loot cultural property as a means of survival and [to] better their chances at reaching safety’ (Fintrail 2022). Norwegian Peo-

ple's Aid (2015) 'is responsible for assisting all' UNHCR-recognised refugees who arrive at Oslo (Gardermoen) Airport for resettlement in Norway; and, between 1994 and 2015, assisted more than 27,000 people, who ranged from Congolese to Syrians to Afghans; yet 'never experienced anyone bring[ing] in any illegal artifacts'. Moreover, it is known that some portable 'objects of cultural value', which had been treasured as cultural assets and could have been converted into economic assets, have been 'left behind', precisely because they were not absolutely 'essential items' for some asylum-seekers from Syria (Gibbons 2017: 61). Ultimately, Nordic Police and Customs Cooperation concluded that there was 'no basis for confirming this hypothesis, even though the possibility' could 'not be discarded' (Ervik 2017: 44).

With regard to the absence of evidence, it is possible that, before they interacted with Nordic law enforcement agencies, security agencies and/or social support agencies, refugees had sold or delivered any cultural assets to cover the cost of the journey or to ease the burden of resettlement, had been robbed by people smugglers (since mentions of 'violent deaths [and] robberies' at their hands are 'ubiquitous' in interviews of refugees by Dempsey 2020; see also Regional Mixed Migration Secretariat 2017), gangs (Araia and Monson 2009), armed groups (Al Jazeera 2020) or simply opportunistic criminals (Nagai *et al.* 2008: 260; Fernández 2023), or had abandoned any cultural assets because their legal status had been secured and their social protection had been guaranteed. It is possible that, when refugees interacted with agents, those agents simply did not see illicit antiquities, as a valuable ancient coin could have been put in a wallet among tens of valueless modern coins. It is possible that agents saw but did not recognise any illicit antiquities, as ancient jewellery could have been worn as contemporary handi-crafts and non-specialists might not have been able to distinguish between legally-protected cultural goods and legally-unregulated cultural goods. It is further possible that, when managing irregular migration, particularly when managing the migration crisis, law enforcement agents lacked the expertise, the personnel and/or the time (and social support agencies did not have those capacities or the responsibility) to police the smuggling of cultural objects as well. The author of the cur-

rent study was stopped and strip-searched twice on the Turkish-Greek border between 2015 and 2016, was stopped and searched numerous times at various border crossings across South-eastern Europe in the 2000s and 2010s, yet was only ever checked for rite of passage and illicit possession of alcohol, tobacco, narcotics and/or firearms. Asylum-seekers may also have been robbed of cultural goods, as they have been robbed of other goods, by agents of border guards (Mourenza and Malichudis 2023; Reeve and de la Cuetara 2021; Strik 2020; Syrians for Truth and Justice 2020), police forces (Hess and Petrogiannis 2020) or armed forces (Human Rights Watch 2016).

There has also long been evidence for subsistence digging by insecure members of local communities from West Africa to West Asia (Hardy 2015a). In Mali, victims of environmental crisis 'sometimes turn to looting as a way to survive' (Sidibé 2001: 27). In Niger, victims of economic crises turn to looting 'at the limit of [their] daily survival' (Gado 2001: 58; see also Labi and Robinson 2001 on Nigeria). In Palestine, most looters 'dig as a way of surviving poverty' (Yahya 2010: 98, 97). In Jordan, victims of economic crises turn to looting in 'a desperate effort to feed their families' (Politis 1994: 15; see also Bisheh 2001: 115). During the civil war in Syria, 'poverty and lack of work opportunities forced simple farmers to dig [loot]' (according to an eyewitness, interviewed by Almohamad 2022: 67). In the multidimensional crises in the aftermaths of wars in Iraq, 'forbidding people from looting archaeological sites would [have] mean[t] condemning them to starvation' (Farchakh Bajjaly 2007: 52; see also Foster, Foster and Gerstenblith 2005: 220; Russell 1996). It only stands to reason that the same choices would be made by other people in the same situation.

There is a coincidence between flows of cultural objects and flows of forced or involuntary migrants, in the same way that there is a coincidence between flows of cultural objects and flows of other people or other goods (Kathimerini 2016; Roland 2015). Again, logic infers *some* looting and trafficking of cultural assets as economic assets, as has been documented for other available, portable and convertible assets (cf. Friedman 1998; Kim 2015; Mac Ginty 2004: 862–863; Rubenstein 2010).

Indeed, a journalist (personal communication, 29 November 2015) witnessed child refugees from Guatemala ‘by the roadside in El Salvador [around] 1993’, who were ‘selling Mayan figurines’. The author of the current study was offered cultural objects in Greece by refugees from Afghanistan in the early 2000s and, during research and capacity-building, heard various mentions of intersections between flows of forced migrants and flows of trafficked antiquities throughout the 2010s.

Furthermore, established experts, with clear access to unpublished data, have stated that ‘small objects [petites pièces]’, such as ‘jewellery, coins, statuettes [and] religious books [bijoux, monnaies, statuettes, livres religieux]’, are ‘increasingly carried [de plus en plus souvent véhiculées]’ into Europe ‘by the massive influx of refugees [par l’afflux massif de réfugiés]’ from North Africa and West Asia, ‘who use them as a very practical trading currency to pay the smugglers [qui s’en servent comme d’une monnaie d’échange très pratique pour payer les passeurs]’ (e.g. Michel 2020: 63). However, naturally, they have not been able to publish their confidential, corroborating data.

Nonetheless, neither theoretical logic nor anecdotal evidence demonstrates the existence of a significant flow, let alone a common phenomenon. As demonstrated by the disagreements over the *existence* of such activity, there has been no sustained study of it and there is no accepted body of evidence. Indeed, another reason that Nordic Police and Customs Cooperation found ‘no basis for confirming this hypothesis’ (Ervik 2017: 44) was that no study had been published.

In the end, there has been an understandable yet nevertheless manifest lack of attention paid to the phenomenon by law enforcement agencies, security agencies and scholars of archaeology, heritage, crime, security and forced migration; there has been justifiable evidentiary caution about the reliability and significance of the isolated cases that have been observed in the course of other work; and there has been justifiable moral concern about the human implications of any potential responses of state and society at a time when the phenomenon of migration in and of itself is widely identified as a crisis, particularly when ‘crime control and immigration control’ are being merged into ‘crimmigration’ control (Stumpf 2014: 237). Therein, its potential consequences for forced migrants are par-

ticularly significant, as cultural property crime may be (in the United States) legally judged to be or (in other jurisdictions) implicitly recognised as a crime involving moral turpitude (CIMT) which may be punished by deportation (Stumpf 2014: 241).

Consequently, until now, the disparate observations that have been compiled in this study have simply gone unnoticed or have otherwise been dismissed, downplayed or obscured. Yet, at least in the case of illegal handling of cultural property, it may not help anyone to turn a blind eye to this potential issue. This cedes the ground of the discussion to anti-migration activists, who have a vested interest in issues that taint the perception of forced migrants, and collectors and dealers, who have a vested interest in issues that may serve as moral neutralisation of their risky handling of undocumented cultural goods.

This preliminary open-source research identifies a multitude of primary sources, including netnographic data, as well as secondary sources, which document activity that has never been subjected to extensive analysis. Due to a range of factors that are considered under the limitations of the evidence, little of the material relates to events in Europe in the 20th century. Then, with a primary focus on the people who are involved rather than the objects that are handled, this study traces empirical foundations for assertions of intersections between forced migration of people and financially-compelled trafficking of antiquities; it insists on simultaneous caution against careless repetitions of such assertions, due to the potential harm of the misunderstanding and misuse of evidence; and it argues for policies that minimise cultural harm, as a component of efforts to minimise humanitarian suffering, since humanitarian suffering and cultural harm can form a vicious circle.

DEFINITION

Cultural objects

There are innumerable legal, academic and popular definitions of archaeological goods underwater, underground, on the ground and in standing structures; more or less historic artefacts, religious artefacts and artworks in standing structures, public collections and private collections; and other contemporary objects, which may gain the status

of significant objects through the nature of the objects themselves and/or the treatment of those objects. Even when only considering the law, the definitions of protected objects and the extent of that protection, plus the existence and nature of prohibited actions (such as looting, theft, smuggling, illegal export, illegal import, trafficking, illegal sale and/or illegal purchase), typically vary between states and occasionally vary between jurisdictions within states or even between categorisations of lands and properties within jurisdictions.

The present study could not be conducted according to a narrow definition, which would inevitably exclude cultural objects that are significant for their communities of origin, especially when so many of the sources that recorded suspected crime with cultural property by forced migrants were neither legal proceedings nor academic studies. Consequently, the objects of the study's analysis encompassed those that had been identified as antiquities, artefacts or equivalent terms by the sources that recorded their looting, theft, smuggling and/or trafficking. Nonetheless, these fell within the definition of 'cultural property' as property that has 'importance for archaeology, prehistory, history, literature, art or science', according to UNESCO's (1970) Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property.

Forced migrants

Information was sought on the illegal handling of cultural objects as a subsistence strategy of forced migrants. Wherever possible, on the basis of identifiable, accessible and assessable sources, "forced migrants" encompassed refugees who were displaced before the establishment of international conventions. They also encompassed externally displaced persons who were refugees that were in receipt of protection under international humanitarian law, due to persecution of their race, nationality, religion, particular social group (such as a trade union or a minority of sex, gender or sexuality, including victims of intimate partner violence and other domestic abuse in jurisdictions where there is a denial or failure of state protection) or political opinion (which may include resistance to violence on the basis of sex, gender or sexuali-

ty), according to the United Nations' (1951) refugee convention (since it came into force in 1954). Likewise, they encompassed refugees who were in receipt of protection under regional humanitarian law, on the basis of generalised or otherwise indiscriminate violence, according to the refugee convention in Africa (Organization of the African Union, 1969), since it came into force in 1974; the refugee declaration in Latin America (Colloquium on the International Protection of Refugees in Central America, Mexico and Panama, 1984), as it has been implemented or derivative legislation has been adopted by various states since then; and the refugee directive in the European Union (European Parliament and Council of the European Union, 2011), since it came into force in 2012. Equally, they included externally displaced persons who were in receipt of support that technically avoided their categorisation as refugees under international law, such as temporary protection. Concomitantly, they included asylum-seekers who were in search of guaranteed safety. Furthermore, they encompassed internally displaced persons (or IDPs), who could not have had official status under international law and may not have had official status under national law.

Since displacement by environmental degradation and resource conflict (which are typically products of political economy, rather than ecological inevitability, cf. Erdoğan and Cantürk 2022; Morales-Muñoz *et al.* 2020; Niazi and Hein 2017; Norwegian Refugee Council 2008) is still involuntary displacement, refugees and IDPs included environmentally induced forced migrants (cf. Dun and Gemenne 2008: 10) and other political-economic migrants (cf. Achiume 2017: 143), as well as specifically-persecuted refugees. Obviously, the legal statuses of the people in the cases that are cited in this study are not known to the author.

METHOD

Identification of the evidence

To ensure open science – accessibility, assessability and reproducibility – the methods of data collection were simple. Initially, relevant sources were identified among the first 100 results of searches on Google Scholar for: antiquities+asylum+seekers; "antiquities"+"asylum seekers"; an-

tiquities+refugees; and “antiquities”+“refugees”.

Then, relevant sources were identified among the first 100 results of searches on Google Books for: refugees+antiquities+looting; refugees+antiquities+smuggling; and refugees+antiquities+selling.

Further relevant sources were identified among the first 100 results of searches on Google for: “antiquities”+“refugee”; “antiquities”+“refugees”; “artefact”+“refugee”; “artefact”+“refugees”; “artefacts”+“refugee”; “artefacts”+“refugees”; “artifact”+“refugee”; “artifact”+“refugees”; “artifacts”+“refugee”; “artifacts”+“refugees”; “displaced”+“antiquities”+“trafficking”; “displaced persons”+“antiquities”; “displaced persons”+antiquities+looting; “displaced persons”+antiquities+smuggling; “displaced persons”+antiquities+selling; “refugee camp”+antiquities+looting; “refugee camp”+antiquities+smuggling; “refugee camp”+antiquities+selling; “refugee camps”+antiquities+looting; “refugee camps”+antiquities+smuggling; “refugee camps”+antiquities+selling; refugees+antiquities+looting+caught; refugees+antiquities+looting+detained; refugees+antiquities+looting+arrested; refugees+antiquities+smuggling+caught; refugees+antiquities+smuggling+detained; refugees+antiquities+smuggling+arrested; refugees+antiquities+selling+caught; refugees+antiquities+selling+detained; refugees+antiquities+selling+arrested; “refugee”+charged+“antiquities”; “refugee”+prosecuted+“antiquities”; and “refugee”+convicted+“antiquities”.

In addition, the crises in Syria and Iraq prompted notable public discussion regarding trafficking by refugees. So, relevant sources were identified among the first 100 results of searches of media in early transit countries – specifically in Iran’s Tehran Times, Iraq’s Baghdad Post, the Jordan Times, Lebanon’s Daily Star and Turkey’s Hürriyet Daily News – and searched both internally through their own online archives and externally through Google, for: refugees+antiquities.

Apart from the aforementioned, incidentally-learned information in the introduction, which was incorporated in ways that confidential sources could not be identified directly or indirectly, only open sources (or almost-open sources, such as Google Books) were used (including concurrently, incidentally-identified information from

netnography), so no ethics approval was required. Where relevant sources (e.g., Hardy 2019c: 389) had cited other sources (e.g., Graham 1979: File 54/114, cited by Gutchen 1983: 227n37; Matsuda 1998a: 57–61), the original sources were used. Where potentially relevant sources did not clearly present looting for the conversion of cultural assets into economic assets, those sources were excluded.

For instance, Rajagopalan (2016: 219n75) stated that, in the maelstrom of the partition of India and Pakistan in 1947, some ‘storehouses’ of monuments and museums had been ‘looted... by the refugees’, but seemingly implied that they had been ransacked to destroy cultural assets – subjected to iconoclasm by extremists among the refugees; and Vesti (2022) stated that four suspected looters, who were citizens of Ukraine with ‘temporary residency [привремен престој]’ in North Macedonia, had been caught and arrested at the specifically-protected site of Isar near Marvinci, in possession of three metal-detectors, shovels and dug-up antiquities, but did not categorise or otherwise indicate that they were asylum-seekers rather than migrant workers. Neither of these cases was secure enough to be included.

The identities of sources in online forums and social networks – open-source data from online ethnography or netnography – were anonymised and coded by their location (not their origin or identity), their activity and an arbitrary distinguishing number. So, a Ukraine-based artefact-hunter might be UAAH001.

Limitations of the evidence

Although this study also attempted to capture particularly rich evidence in relation to ongoing crises in West Asia, it did seek evidence of the phenomenon regardless of time or place. Yet, it may have found disproportionately less evidence of the phenomenon in the 20th century (or earlier) than in the 21st century and/or in Europe than in other regions (beyond West Asia). This appears to be a result of a combination of a dearth of published data, wherein significant concern with intersections between cultural property crime and migration is a recent phenomenon, which has been bound up with significant concern with intersections between cultural property crime and

security; a dearth of available sources, wherein inaccessible sources are more likely to be older sources; and a mismatch between key words and everyday words, wherein older sources may be more likely to identify the goods by either more specific terms such as their particular types or less specific terms such as “heirlooms”, as well as less likely to characterise the transfers as *illegal* transfers.

Furthermore, mass digitisation and online archiving of publications in open sources or almost-open sources, such as Google Books, has enabled the recovery of evidence that would previously have been invisible or would only have re-entered the specialist discussion of cultural property crime through serendipitous reading. It was known that at least one relevant source (Naylor 2008) was available in Google Books, yet it did not appear in the checked results. At the same time, publishers’ prevention of search engines’ indexing and/or previewing of journal articles, books and media reports and media organisations’ intermittent removal of published reports have prevented the identification or analysis of some online evidence. The undervisibility of some sources and invisibility of other sources reaffirm that this sample is an under-representation of the size of the body of evidence.

LOOTING AND TRAFFICKING BY INTERNALLY DISPLACED PERSONS

There is tentative evidence that, depending on the situation, displacement can either increase looting, by increasing the presence of people without sustainable livelihoods or sufficient aid and reduced cultural property policing (cf. Hardy 2014: 462), or reduce looting, by reducing the presence of looters and traffickers and increasing securitisation (cf. Casana and Laugier 2017: 22). Either way, as it has been prompted by one crisis after another, subsistence looting and subsistence trafficking by internally-displaced persons can be documented across more than a century. At the start of the 20th century in the territory of the Ottoman Empire that is now Syria, ‘Circassian refugees’ collaborated with locals in the looting of sites around Raqqa (according to eyewitnesses, cited in correspondence between the

excavation officer of the Imperial Museum of the Ottoman Empire and the director of education for Halep Province in 1906 and 1907, and cited in the appendices of an exhibition catalogue by Jenkins-Madina 2006: 199).

Such activity spans the globe. In Mali, by the 1990s, Gao had ‘expanded dramatically... to accommodate refugees from the Sahel droughts’; due to this urban encroachment and development, formerly rural cemeteries were subjected to ‘illicit digging’ (Insoll 1993: 630). In Guatemala, sites have been occupied and looted by refugees who have been subjected to ‘relocation’ after their return from exile in Mexico (Paredes Maury 1999: 16).

Such activity can be seen to persist. At the start of the 21st century in Turkey, internally displaced persons, who had been forced to migrate by domicidal infrastructure projects, ‘turned to antiquities trafficking to replace lost income’ (Taylan and Arca 2001). In Afghanistan, illegal excavation is ‘occasionally’ conducted ‘by people from refugee camps’ (Teijgeler 2015: 56).

In Syria, ‘conditions are so bad in refugee camps that many people’, including the relatives of the source in a refugee camp in Syria near Turkey, ‘have been forced into illegal excavation to earn some money’ (according to Participant 6, cited by Brodie and Sabrine 2018: 78). Online traffickers in Syria include ‘vulnerable populations’ of internally displaced persons who are ‘subsistence looters’ (al-Azm and Paul with Graham 2019: vi). Some internally displaced persons, such as Participant 6, sometimes deal in cultural objects (cited by Brodie and Sabrine 2018: 78).

For instance, within the UNESCO World Heritage site of the Ancient Villages of Northern Syria, in the ancient city of al-Bara, ‘new residents’ (recently displaced persons) ‘broke into the royal tomb to sell its contents as antiques [*sic* - antiquities]’ (al-Ibrahim and Fayyad 2015); they ‘destroyed the old royal tomb in order to sell it as antiquity pieces’ (SIRAJ and ARIJ 2016). Elsewhere within the World Heritage site, in Shinshirah (also known as Shinshra, Shenshara and Shemshara), where informally-encamped internally displaced persons had been hit by regime forces with barrel bombs and air strikes (according to the Association to Protect Syrian Archaeology and the Damascus Bureau, cited by Heritage for Peace 2014), people ‘smashed up stones from ancient

houses into smaller pieces to sell them' (al-Ibrahim and Fayyad 2015). They were 'selling ancient rocks to raise funds that would allow them to build new houses' (SIRAJ and ARIJ 2016) or simply 'to afford potable water' (according to civil society activist Hammoud al-Juneid, cited by Damascus Bureau 2014). This problem appears to have persisted (cf. Nassar and Atieh 2020).

LOOTING AND TRAFFICKING BY EXTERNALLY DISPLACED PERSONS

Likewise, subsistence looting and subsistence trafficking by externally displaced persons can be documented across decades. In flight from China's occupation of Tibet since 1950, 'refugees' took 'cultural objects' such as 'textiles, statues, jewellery, manuscripts, furniture, sacred objects, and costumes' and 'sold [them] for sustenance' in Nepal, where they were bought up then sold off on the markets of the United Kingdom and the United States (Smith 2022: 265).

In the aftermath of the Indo-Pakistani War of 1965, refugees (as well as others) who moved between India and Pakistan 'smuggle[d] out... looted antiquities' and other commodities instead of inconvertible currency (Naylor 2008: 69).

Such activity also spans the globe. In the 1970s, 'treasures' were 'looted... by refugees' who were 'fleeing the Khmer Rouge' (Mydans 1999); they 'brought sculptures across the border to Thailand, where there were dealers ready to receive them' (according to Cambodian archaeologist Sopheap Meas, interviewed by Christodoulou with Beale 2022). At the same time, 'Cambodian refugees' in Thailand 'who lived in the camps near the Thai border were trained' by foreigners from outside the region 'to go into the temples scattered all over the [jungles] to look for whole statues and torsos and heads of statues' (Lafont 2004: 2; see also Lafont 2004: 37–38).

From the 1970s onwards, in Latin America, there has been 'subsistence digging' of cultural assets by 'internally and externally displaced peoples' (Matsuda 1998a: 3). In Belize, evidence includes participant testimony of bartering by a dealer of 'clothes, food, and medicine for *artifacts* [artefacts]' extracted through subsistence digging by displaced persons (Matsuda 1992: 34;

by the end of his study, he had interviewed 400 subsistence diggers in Central America, 'most' of whom 'were refugees from civil violence and economic despair', cf. Matsuda 1998b: 91). There, 'illegal residents' – in other words, externally displaced persons from Guatemala, Honduras, Nicaragua and El Salvador – carried out 'much of the looting' (Graham 1979: File 54/114, cited by Gutchen 1983: 227n37; see also Matsuda 1998a: 57–61; 112, for an ethnography of 144 subsistence diggers in the country). 'With the government [of Belize] cracking down on the marijuana trade, more and more refugees [largely from Guatemala, though also from Honduras, El Salvador...] are being forced into pillaging sites just to survive. We get a few things back when the police catch someone' (according to archaeologist Logan McNatt, cited by Wright 2000: 36 – bracketed insertion in cited source).

It also emerged in the aftermath of the ousting of the authoritarian monarchy and the establishment of the authoritarian theocracy in Iran in 1979, during the war between the Soviet Union and Afghan Mujahedeen between 1979 and 1989 and the war between Iran and Iraq between 1980 and 1988. Refugees who fled from Iran, if not also refugees who fled to Iran, tried to convert their assets and so became involved in 'the black market in... antiquities', where corrupt 'Pasdaran' – soldiers of the Islamic Revolutionary Guard Corps (IRGC) – 'collected a tithe' on their illicit transfer (Naylor 2008: 232). Such petty corruption will inevitably feed off subsistence trafficking in other cases as well, in the same way that it feeds off ordinary trafficking.

Again, likewise, such activity persists. In the 2000s, there was the smuggling and selling of antiquities by displaced persons from Afghanistan in Pakistan (according to dealers, cited by Ansari 2002: 18), plus the attempted selling of forgeries (according to an anonymous Quetta-based antiquities dealer, cited by Ansari 2002: 19). "Relics", including 'endangered Buddhist and Hellenic statues' were 'sold' to antiquities dealers in Pakistan by 'displaced Afghans' (according to Peshawar-based antiquities dealer Naseer Ahmed, paraphrased by Baldauf 2001). 'Dealers regularly visit[ed] Pakistan's sprawling refugee camps, such as Jalozai', Shamshatoon and a transborder camp that spanned from Spin Boldak in Afghanistan to

Chaman in Pakistan, ‘to purchase Afghan antiquities’ (Ansari 2002: 18); the refugee camp of Kacha Garai near the trading hub of Peshawar was a ‘centre for the trafficking of Afghan antiquities’ (according to the Institute for War and Peace Reporting, after its investigative journalists, Redden with Malak and Awreen 2010, had interviewed a tribal leader in the camp and antiquities dealers in the city).

While opinion varied as to whether the export of statues from Afghanistan was constricted under the Taliban (according to Peshawar-based coin-and-statue dealer Nadir Khan, cited by Baldauf 2001) or ‘increased’, wherein dealers ‘regularly’ had clients from Japan, the United Kingdom, the United States, Pakistan, Saudi Arabia and Kuwait (according to Peshawar-based antiquities dealer Haji Razzaq, paraphrased by Ansari 2002: 18), and while transfers were sometimes ‘delayed’ by events in the war (as explained by Peshawar-based antiquities dealer Haji Razzaq, paraphrased by Ansari 2002: 18), so many sculptures were being smuggled out of Afghanistan, that dealers ‘d[id] n’t have space to store’ all of them (according to Peshawar-based coin-and-statue dealer Nadir Khan, quoted by Baldauf 2001).

In the 2010s, historic artefacts such as religious manuscripts were ‘stolen [dérobés]’ from religious schools (zawiyas or madrasas) by refugees from Mali, Mauritania, Niger and Nigeria and bartered or sold in Morocco, Tunisia, Algeria, Turkey, the Gulf, Europe and North America (according to Dune Voices 2015). Cultural objects were ‘an indispensable treasure [un trésor indispensable]’ for those refugees, as they were the ‘greatest guarantee of being able to afford the costs of the journey [plus grande garantie pour pouvoir se payer les coûts du voyage]’ (according to a refugee from Niger in Morocco, Salima, paraphrased and quoted by Dune Voices 2015; see also the testimony of an anonymous Morocco-based antiquities dealer, interviewed by Dune Voices 2015).

Today, ‘Syrian refugees... sell artefacts at prices well below their value’, while passing through Lebanon (according to an anonymous smuggler, interviewed in a documentary by artist Maeve Brennan, paraphrased by McNutt 2017). Sometimes, refugees ‘transport material’ as couriers or smugglers, primarily into Turkey (according to Participant 5, who rents metal-detectors to small-

scale looting teams in Syria, cited by Brodie and Sabrine 2018: 78), while some refugees in Turkey serve as intermediaries with dealers from Turkey ‘who can arrange for the sale of material to foreign buyers’ (according to Participant 6, cited by Brodie and Sabrine 2018: 78). Some ‘refugees’ engage in ‘smuggling [as] the only way [that] they can afford to eat’ (according to Syrian archaeologist Cheikhmous Ali, paraphrased by Elger 2014). Some, who may or may not be in equally dire straits, also ‘try to sell small items’ for little money in Turkey (according to antiquities dealer Harun Unvar, cited by Parkinson, Albayrak and Mavin 2015).

Such flows can be traced from the earliest to the latest so-called “transit countries”, though they are also places where some of the objects as well as some of the people ultimately reside. As well as Turkey, ‘police have found items with refugees’ who have been arrested in Bulgaria, Serbia and Italy, ‘who were moving the stuff from place to place’ (according to the former head of the Antiquities Recovery Department for Iraq, Muthanna Abed Dawed, cited by Westcott 2020: 31; see also Westcott 2019).

Again, these flows include forgeries as well as antiquities. After the invasion of Iraq in 2003, ‘refugees of Iraqi origin [réfugiés d’origine irakienne]’ trafficked forged antiquities in Switzerland (according to museum conservator Jean-Luc Chappaz, cited by Roselli 2015). Since the eruption of crises in 2011, there has been a ‘massive increase’ in the trafficking of forged manuscripts by citizens of Syria, Turkey, Jordan and Israel - Palestine, who try to increase the saleability of their goods by advertising that they have been ‘smuggled out of Syria to either Jordan or Turkey by Syrian refugees’ (Interpol Jerusalem 2019; see also Hardy 2020a).

Mesopotamian-style figurines, which were found in a tent at a reception centre for refugees in Gruškovje, Slovenia, and which were initially assessed to be antiquities (cf. RTV MMC 2016), were eventually judged ‘most likely [to be] counterfeit [najverjetneje ponarejeni]’ (cf. Libnik 2017; see also Hardy 2019a). Indeed, ‘many counterfeit... items of [West Asian] cultural heritage [veliko ponaredkov... predmetov kulturne dediščine]’ and ‘tourist souvenirs [turistične spominke]’ were found during the ‘refugee wave [begunskim va-

lom]’ (according to Senior Criminal Inspector Uršula Belaj, paraphrased and quoted by Libnik 2017). Particularly as these fake figurines were abandoned at the refugee centre, rather than kept by their carriers, it is reasonable to assume that their carriers were subsistence traffickers, rather than profit-driven criminals.

Furthermore, as found in the course of other research, though their civil/political status may be questionable (see UNHCR, 2014 on avoidance of conscription), there is emerging evidence of the migration of antiquities looters to avoid the risk of harm in the war between Russia and Ukraine or the risk of forced participation in violence through military mobilisation. CZAH001 migrated from Ukraine to the Czech Republic (see Hardy and Telizhenko 2023 for more details); UKAH001, his adult son and UKAH002 migrated from Ukraine to the United Kingdom; BYAH001 migrated from Russia first to India and then Belarus; and TRAH001 migrated from Russia to Turkey. All of them made a point of taking their metal-detectors with them, when they left so many other things behind, and all of them except TRAH001 have testified to metal-detecting in their host countries. (For UKAH001, his adult son and UKAH002, it may now be a legal activity.)

LOOTING AND TRAFFICKING DURING EXTREMELY PROTRACTED DISPLACEMENT

Many displaced populations endure protracted displacement, whether it is defined by a duration of more than three years (e.g., Crawford *et al.* 2015: 5; cf. Devictor 2019) or more than five years (e.g., UNHCR 2020: 24; cf. Devictor 2019). Many endure ‘major protracted refugee situation[s]’, where populations of at least 25,000 are displaced in one country of reception for at least five years yet do not have ‘durable solution[s]’ in sight (Milner and Loescher 2011: 15). Some, such as Palestinian refugees, endure ‘extremely protracted displacement’ (Ferreira *et al.* 2020: 28), in communities and territories that have established somewhat persistent economies and somewhat functioning systems of internal governance. As for Sahrawi refugees, they may have ‘little by way of livelihoods or life prospects’ and become ‘susceptible to recruitment’ by violent political

extremists such as ‘jihadist organizations’ (Jacobsen 2017: 8).

Some of the cases that have been discussed have occurred under these circumstances. Other cases have worsened or emerged in the immediate aftermath of displacement, then persisted as the situation has turned into first protracted displacement then extremely protracted displacement. For instance, it is believed that displaced small-scale farmers (*campesinos*) in Guatemala ‘no doubt’ continue to ‘discover unrecorded’ cultural objects and sometimes engage in opportunistic looting of such incidental finds (Yates 2014: 34).

Financial need was a genuine reason for displaced persons’ involvement in the trafficking of the Dead Sea Scrolls, as well as a cynical instrument for their bargaining in negotiations over possession and profit (Irving 2021: 119–120). The looting of the necropolis of Jericho, Tell es-Sultan, intensified after the recovery of the scrolls which have been attributed to Qumran since 1946–1947; it further intensified as the refugee camp of Aqbat Jabr was established nearby in 1948, then developed into a suburb of the local town of Ariha/Jericho (Nigro 2006: 106). More broadly, the continued demand for papyri and other antiquities is still ‘prompting cash-strapped Palestinian refugees to scour the deserts of the Holy Land, looking for undiscovered treasure troves’ (Associated Press 2014).

In such circumstances, looting and trafficking by individuals who have experienced extremely protracted displacement would partly be driven by the circumstances of their displacement and partly be related to the provision of support and the realisation of integration or return. Nonetheless, it would basically be comparable to everyday subsistence digging in other circumstances of physical and socio-economic insecurity, and profit-driven crime in other circumstances of political instability. So, its reduction would primarily be dependent upon development, education, public engagement and policing.

That *may* have been the case for displaced Palestinians during the Lebanese civil war, as there were ‘clandestine excavations’ at the Palestinian refugee camp of al-Bass/el-Buss near Tyre in Lebanon in 1990 (Seif 2015: 72), which extended towards if not into the UNESCO World Heritage site, whereafter finds were advertised on the local market through a local dealer. In this and other

cases, due to the lack of a legal instrument for seizure, the finds were recovered through “rescue”-by-purchase; private funds were raised to buy the finds for a public collection, thereby preventing their disappearance into the international market (Seif 2015: 72). Such recovery mechanisms may cause other and greater harms, both to the victimised community who are financially compelled to extract antiquities and to the cultural heritage that is supposedly “rescued” (cf. Hardy, 2020b; 2021).

Likewise, this *may* have been the case for prehistoric arrowheads that had been ‘collected in the Free Zone’ or Liberated Territories of the Sahrawi Arab Democratic Republic in the Western Sahara and sold in the Sahrawi refugee camp of Smaara near Tindouf in Algeria in 2002 (Brooks 2005: 426). Similarly, a home in Hitteen Refugee Camp (also known as the Schneller Refugee Camp) for displaced Palestinians in Jordan was raided and its ‘resident’ was detained, because he had been trying to sell 21 Roman and Byzantine antiquities, ‘includ[ing] gold, bronze and stone statues’ (Petra 2015).

However, many individuals and communities move back and forth with the ebb and flow of violence or insecurity (World Bank 2017: 49), as within Nigeria or between Nigeria and Cameroon and within Afghanistan or between Afghanistan and Pakistan. Indeed, there is specific evidence of this in relation to cultural goods. As persistently unsettled Afghans repeatedly traverse the border, dealers in Pakistan ‘often place orders with refugees’ for when they return to Afghanistan (Ansari 2002: 18).

DISCUSSION

The legal status of private collections of suspect cultural objects

Unlike “ordinary” private collections of looted antiquities, which might be characterised as private collections of tainted cultural objects *in the possession of politically-powerless persons*, private collections of sincerely or insincerely “rescued” antiquities, which are typically private collections of tainted cultural objects *in the possession of politically-exposed persons (PEPs)*, are sometimes accorded – or treated as if they have

been accorded – a peculiar legal status. For instance, during the civil war in Cyprus, the Greek Cypriot administration allowed ‘illegal’ collecting by Greek Cypriot collectors of ‘illicit’ antiquities from Turkish Cypriot looters under a ‘silent accord’, which was concomitantly never established in law, then legalised those collections (Hardy 2014). In Guatemala, the state has facilitated the re-import of looted antiquities and the legalisation of collections of “rescued” antiquities through omissions of declarations of illegal origins (Hardy 2020b). In Pakistan, the state has not prosecuted or denounced the collecting of stolen artefacts from Afghanistan by its (now past) prime minister and internal security minister (Hardy 2021). Contrarily, Norway has compelled the repatriation of supposedly “rescued” goods to Afghanistan and Pakistan (Hardy 2021).

Due to the fact that private collections of careful criminals resemble private collections of careless good-faith buyers in their limited record-keeping, which can suffice to prevent the production or preservation of forensic evidence of the legality or illegality of a possession, the contents of any private collection of undocumented cultural objects can have a questioned legal status. For instance, following a police operation to investigate Martin Schøyen’s antiquities collection by Norway’s National Authority for Investigation and Prosecution of Economic and Environmental Crime (Økokrim), with assistance from the Museum of Cultural History of the University of Oslo (UiO KHM), the National Library of Norway (NL) and the Department of Archaeology, Conservation and History of the University of Oslo (UiO IAKH), the public records were found to contain ‘opaque, generic, and often conflicting’ statements and the private records were found to contain ‘generic, euphemistic or potentially fictitious’ statements (UiO KHM 2022: 4). Even when a false record could be identified, the source(s) of that misinformation – the collector, his suppliers and/or their suppliers – could not. Additionally, sometimes, the legal status of the possession could not be determined either.

Misunderstanding of antiquity flows by antiquities markets

Art and antiquities markets express concern

that regulation to prevent conflict financing and other criminal exploitation of cultural goods from conflict zones might prevent subsistence sales of legal possessions by refugees (e.g., Antiquities Dealers' Association 2016; British Art Market Federation, cited by the United Kingdom House of Commons Culture, Media and Sport Committee 2008: Ev. 13–17; Tompa 2014). For example, a United States based coin collector 'suspect[ed] that] many of the antiquities' that had arrived in Western markets since the outbreak of crises in 2011 had 'come from the private collections of four million Syrian refugees' (Snible 2015). Another United States-based coin collector, who is a lobbyist for antiquities collectors and traders, was 'interest[ed]' in 'how much material that [was] characterized as "looted" [was] actually [the] personal property of Syrian refugees', as there were 'plenty of collectors in Syria before the war amongst the educated class' (Tompa 2016). However, the existence of collections does not indicate the legality of their contents. Furthermore, the volume of antiquity flows cannot be explained by the export by refugees of "orphan works" that are legal yet can no longer be proved to be legal – and there is no material evidence of legal proceedings against such refugees. As such, an insistence upon this argument might be perceived as an excuse to minimise any regulation of the market.

Although looting, trafficking, and handling would be illegal either way, sometimes, the potential for involvement of refugees is deployed in debates over the "rescue"-by-purchase of cultural goods that have been (or are alleged to have been) smuggled out of conflict zones (see discussion in Hardy 2021; see also Hardy 2020b). For instance, while advocating "rescue"-by-purchase of antiquities that have been looted in Syria and Iraq, a United States-based member of the market aligned Committee for Cultural Policy, who is a consultant to dealers and collectors of art, suggested that 'some of the money [would] likely go to refugees' (Vikan 2015). Norway-based antiquities collector Martin Schøyen and academic collaborators such as Jens Braarvig have specifically, yet baselessly, asserted that the Buddhist antiquities in the Schøyen Collection were smuggled out of Afghanistan by refugees (e.g. Schøyen, 23 October 2000 and 21 November 2001, translated and cited by Prescott and Rasmussen 2020: 71–

72; Schøyen Collection 2010; Schøyen Collection 2020; for analysis of the case, see Lundén 2005: 3–4; Omland and Prescott 2002: 5; Prescott and Omland 2003: 10; Prescott and Rasmussen 2020). As such, an insistence upon this argument might be perceived as an attempt to valorise consumers of illegal stolen goods, whose demand drives the supply, for reducing the harm of a problem that they cause.

While this study has confirmed the existence of historically deep and geographically broad evidence of illicit trafficking of cultural objects by forced migrants, including forced migrants from Afghanistan and Syria, its piecemeal findings simultaneously suggest that it is false to present the purchase of undocumented antiquities as "likely" to benefit refugees and particularly dangerous to do so when it is more likely to benefit the violent political organisations that are driving displacement and regulating the movement of people and goods.

For instance, while, *currently*, in *some* territories, there is only evidence for *piecemeal* handling of cultural goods by forced migrants and, in *other* territories, there is only evidence for *wide-ranging* handling of cultural goods by members of violent political organisations (when this study is compared with Hardy 2019b), antiquities have been documented to have been handled by *both* forced migrants *and* members of violent political organisations in Afghanistan and Pakistan, Cambodia and Thailand, Iran, Iraq, Israel - Palestine, Lebanon, Mali, Nigeria, Russia, Syria, Turkey and Ukraine (see Hardy 2023). Furthermore, some market actors have political interests as well as commercial interests in facilitating a specifically culturally-destructive trade. For example, while some patriots, such as Peshawar-based displaced Afghan antiquities dealer Ghaznavi (who was interviewed by Baldauf 2001), who had 'Iranian, Afghan, Greek, and Saracenic artifacts', would only sell displaced Afghan antiquities when they had 'no choice' to feed their hungry family; some Islamists, such as Peshawar-based Pakistani dealer Salar (who was interviewed by Baldauf 2001), whose safe was 'full of Buddha heads and figurines', have 'support[ed] the Taliban' in its iconoclasm. This underlines the threat of the illicit trade to the very possibility of re-establishing intercommunal cultures of peace. Concomitantly, it highlights the challenges of empathetic responses

to illicit trafficking of cultural goods by forced migrants. Policing of subsistence activity that facilitates forced migration may have inhumane consequences. Yet, equally, non-policing may have other inhumane consequences, particularly when migrant flows are exploited by professional criminals, organised criminals and violent political organisations to facilitate their movement of members and dirty assets.

Exploitation of refugee flows by antiquities traffickers

In certain early transit countries, many alleged reports of trafficking of art, artefacts or antiquities by refugees actually reveal the trafficking of counterfeits, fakes or forgeries (see Handby 2023, for analysis of the trafficking of forgeries; see Hardy 2020a, for evidence of exploitation of conflict and displacement to provide false provenances for forgeries). Some forgers piggyback on crises and produce fakes that resemble antiquities from persecuted minorities or those from conflict zones, including fake conflict antiquities that are marketed as stolen by armed groups, in order to lend false legitimacy to their alleged provenance (Hardy 2017). For instance, there has been a trickle of fraudulently advertised cultural goods in Turkey, such as counterfeit Picassos that have supposedly been obtained from Iraqi soldiers (e.g., Anderson 2001; cf. Ergül n.d.) and fake antiquities that have supposedly been ‘obtained... from Syrian refugees’ (e.g., Sabah 2015; cf. Hardy 2015b). There is now a stream of fraudulently advertised cultural goods in Russia, which are fake antiquities that have supposedly been looted in Ukraine (according to a looter in Russia, RUAH002). These join a flood of genuine antiquities that were actually looted in Ukraine (according to RUAH001 and RUAH003).

If they are caught, criminals may also claim to be refugees, rather than professional criminals, members of criminal organisations or members of violent political organisations, in order to protect themselves from the risk of more serious charges by police or retribution from partners-in-crime (according to law enforcement agents in an early transit country, personal communication, 18–22 October 2015). Whether law enforcement agents are unable to disprove these lies or whether they

choose not to challenge them, as such convenient falsehoods obscure the persistence of organised crime and the financing of political violence, some false claims may enter the record.

Moreover, refugee flows may be exploited by professional criminals to obscure commodity flows. For instance, in Afghanistan, sculptures from the Buddhist monastery in Hadda were smuggled out of the country by being ‘concealed amongst the many refugees fleeing the conflict’ (Cassar and Noshadi 2015: 18).

With regard to Syria, terrorist-serving antiquities dealers, armed groups, security forces and Western officials have testified to trafficking by professional criminals who conceal themselves within refugee flows (e.g., Faucon, Kantchev and MacDonald 2017). Early in the war, perhaps ‘most of the illicitly acquired artifacts [were] smuggled into Jordan amid the daily influx of about 2,000 refugees’ (according to sources in the Free Syrian Army and Jordan’s security forces, cited by Luck 2013). In Jordan, ‘a group of men’ from Russeifa city were arrested for trying to sell weapons and a forged antiquity in the Hitteen Refugee Camp for displaced Palestinians (Husseini 2015).

In Lebanon, ‘gangs put things [among] the belongings of the refugees’ (according to the head of the Bureau of International Thefts in Lebanon, Col. Nicholas Saad, cited by Cox 2015; see also Saleh 2016; elsewhere e.g., The Docket 2022: 73, this has mistakenly been cited as evidence that antiquities were smuggled ‘by refugees’). Law enforcement agencies and security forces have intercepted cultural objects that were ‘concealed within the belongings of Syrian refugees’ by professional criminals (according to Col. Saad, paraphrased by Kadi 2015). For instance, ‘Lebanese customs at the border crossing of Masnaa... seized 18 Roman mosaic panels on a bus carrying refugees’ (according to Col. Saad, quoted by Kadi 2015).

Crimmigration

In fact, there is a ‘detectable nonzero’ association between a higher rate of immigration and a lower rate of crime *overall*, of such a tiny magnitude that it is ‘nonsignificant’ (Ousey and Kubrin 2018: 69), and a detectable, nearer-to-zero association between a higher rate of immigra-

tion and a higher rate of *property* crime, of such tiny magnitude that it is meaningless (Ousey and Kubrin 2018: 74). However, these neutral findings may obscure complexities, such as a higher rate of avoidance of all categories of crime by most immigrants at the same time as a higher rate of participation in *particular* categories of crime by other immigrants, including variations over time between entry and integration and differences between communities on the basis of the ease of their entry and integration (cf. Guia 2013; Jennissen 2013; Leerkes, van der Leun and Engbersen 2013).

Regardless, there are increasing obstacles to and restrictions on entering, remaining and integrating (Gerard and Pickering 2013; Scheel and Squire 2014), which may lead to increasing incidences of subsistence crime among forced migrants (cf. Leerkes, van der Leun and Engbersen 2013). Concomitantly, there is an increasing risk that forced migrants may be deprived of necessary protection on the basis of subsistence crime or suspected crime that is necessitated by the political violence and the crimmigration regime of which they are victims.

A very limited sample of more extensive evidence

It must also be remembered that displaced persons include professional criminals who have continued or started to handle illicit antiquities, such as internally displaced multi-commodity trafficker Ayham in Syria (Mabillard 2013); and professional crime may become subsistence crime, as it has for externally displaced multi-commodity trafficker Mohamed in Turkey, who had been profiting from smuggling antiquities since the early 2000s, but has been ‘support[ing] his extended family’ since they became refugees in the early 2010s (Giglio and al-Awad 2015). So, some cases are extremely difficult to categorise. For instance, in the early 1990s, a refugee from Bosnia ‘offered’ to sell or mediate the sale of paintings in Belgrade that had been stolen from Sarajevo (according to then-curator of the Museum of Modern Art in Belgrade, Jovan Despotović, cited by Walasek *et al.* 2015: 75).

There have been numerous sources that have presented specific cases or particular processes of

looting or trafficking by internally and externally displaced persons, on the basis of testimony from forced migrants, professional criminals, cultural heritage workers or law enforcement agents. Looting and trafficking by internally displaced persons has been conducted since the time of the Ottoman Empire and, within the last thirty years, it has been documented in Guatemala, Mali, Turkey, Afghanistan and Syria. Looting and trafficking by externally displaced persons has been conducted by refugees from China’s occupation of Tibet; refugees from war between India and Pakistan; refugees from civil war, dictatorship, genocide and occupation in Cambodia; refugees from dictatorships and dirty wars across Central America; refugees from the revolution in Iran and the war between Iran and Iraq; refugees from civil war in South-eastern Europe; refugees from war and terrorism in Afghanistan; refugees from war, terrorism, dictatorship and environmental-economic collapse across West Africa, North Africa and West Asia; and refugees from the war between Russia and Ukraine. Refugees from West Africa, North Africa, West Asia and Eastern Europe have engaged in online trafficking to reach markets in Western Europe and North America and beyond.

However, much evidence may have been incidentally excluded, due to the keywords for data-gathering and the everyday words for cultural objects among refugees, authorities, academics and journalists; standard practices in the media/publishing industry; and subjects of interest to authorities, academics and journalists. For instance, due to the design of the study, non-English-language sources (e.g., Dune Voices 2015) were practically excluded. Likewise, less prominent sources (e.g., Hussein 2015; Petra 2015; RTV MMC 2016) were obscured in searches on Google and even searches on news platforms by more heavily weighted sources, including false-positive results. However, English-language, open-access work-in-progress included material from French, German, Slovenian and Turkish sources (e.g., Hardy 2015b; 2016: 9; 2017; 2019a), thereby (unsurprisingly) demonstrating that they do exist. For instance, Greek reporting has included testimony that ‘refugees who travel through Greece have carried objects (gold coins, seals [, etc.]) as a form of extra income [πρόσφυγες που μετακινούνται μέσω Ελλάδας έχουν κουβαλήσει

αντικείμενα (χρυσά νομίσματα, σφραγίδες) σαν μορφή επιπλέον εισοδήματος]’ (according to Syrian archaeologist Amr al-Azm, quoted in translation by Papadopoulos 2018).

In addition, while it is difficult to establish their civil/political and socio-economic status, there are online traffickers from conflict zones residing in peaceful countries, such as a ‘likely displaced’ person from Syria in Germany (al-Azm and Paul with Graham 2019: 21), who attempted to sell a fake mosaic (see discussion under ATHAR Project 2019). While some may be local operators in Europe, such as those beyond the zones of these migrant flows in West Africa, South Asia, South-East Asia and South America, online communities for illicit traffickers of cultural objects from North Africa and West Asia include administrators (and almost definitely, lower-level participants) in Bulgaria, North Macedonia, Italy, Germany, France, the United Kingdom, Canada and the United States (al-Azm and Paul with Graham 2019: 64–80), as well as administrators (and so surely also lower-level participants), who may have been displaced within the region. As noted in the introduction, there is also netnographic evidence in relation to the war between Russia and Ukraine. This, too, suggests that there is evidence that is currently out of reach, which might be teased out through oral history, face-to-face ethnography and online ethnography.

CONCLUSION: IMPLICATIONS FOR POLICY AND PRACTICE

This issue is all the more critical, as, on the basis of one piece of ethnographic testimony (e.g. Berends 2020: 52, citing Brodie and Sabine 2018: 78; though more extensive evidence was already available, e.g. Dune Voices, 2015), the expectation that refugees may be involved in looting is now being included in guidance for cultural property protection (CPP) personnel, within and beyond the CPP specialists who are expected under the 1954 Hague Convention (High Contracting Parties, Ch. 1, Art. 7, Para. 2). Ultimately, this study confirms preliminary observations that, ‘due to global failures in civilian protection, refugee protection and migration management, asylum seekers’ and other forced migrants are being financially ‘compelled to use cultural assets’ as

economic assets (Hardy 2019b: 19). While illicit trafficking of cultural objects encompasses a much broader spectrum of actors, activities and circumstances, including organised crime, violent crime and terrorist financing within secure states in typically upper and upper-middle-income countries (alternatively characterised as the Global North/West), there is historically-deep and geographically-broad evidence of looting, trafficking, smuggling and/or sale by internally displaced persons and externally displaced persons from typically lower-middle and lower-income countries (or the Global South/East). This activity enriches existing revenue streams for corrupt officials, organised criminals and armed groups in and around conflict zones, intensifying conflict, undermining peace-building and reinforcing pathways of destabilisation along routes of forced migration.

Like the depletion of other resources, it thereby weakens any economic foundations for the return of displaced persons. Without downplaying the social, cultural and political value of sustainable economies that are built around non-cultural commodities, illicit trafficking of cultural objects (whether by forced migrants or other actors) perhaps particularly weakens the social, cultural and political foundations for the return of displaced persons and the rebuilding of mixed communities and shared lives that contribute to sustainable peace. Thus, the antiquities market should revise its perception of the possibility of subsidising refugees and reckon with the far greater risk of financing political violence and undermining the rule of law. More immediately (and perhaps more realistically), reinforcing the findings of the study for the Netherlands’ War Crimes Unit (van Lit 2016: 65–67), the possibility of illicit trafficking of cultural objects by forced migrants – and profit-driven criminals who have hidden themselves among forced migrants – should be recognised in training and procedures for migration management agencies and law enforcement agencies. While such a shift in policing involves notable attendant risks, particularly under crimmigration regimes, non-policing of trafficking by forced migrants would facilitate trafficking by professional criminals, organised criminals and violent political organisations *among* forced migrants, which would further endanger refugees from and residents in communities of origin. Furthermore,

ethical policing creates opportunities. As long as it protected refugees as victims and informants, which could also contribute to shifts in mutual attitudes among forced migrants, law enforcement agents and citizens, it could recover cultural assets, generate intelligence on violent political organisations and thereby reduce harm and risk to forced migrants and communities of origin.

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REZIME

NEDOZVOLJENA TRGOVINA KULTURNIM DOBRIMA OD STRANE PRISILNIH MIGRANATA

KLJUČNE REČI: PLJAČKANJE ANTIKVITETA, TRGOVINA ANTIKVITETIMA, KRIMIGRACIJA, KRIMINAL U KULTURNOM NASLEĐU, PRISILNA MIGRACIJA, NEDOZVOLJENA TRGOVINA KULTURNIM DOBRIMA, KRIMINAL U CILJU PREŽIVLJAVANJA, PLJAČKANJE U CILJU PREŽIVLJAVANJA, TRGOVINA U CILJU PREŽIVLJAVANJA.

Postoje tvrdnje da su dobar deo kulturnih dobara iz zona sukoba i kriza prenele izbeglice, odnosno migranti. Pojedini organi za sprovođenje zakona i humanitarni radnici negiraju da postoje dokazi o takvim tokovima predmeta kulturne baštine. Kroz istraživanje otvorenih podataka, ovaj rad dokumentuje slučajeve nezakonitog prisvajanja (kroz pljačku ili krađu), iznošenja iz država porekla i trgovine kulturnim dobrima, tokom perioda od više od jednog veka, koje su počinila interno raseljena i međunarodno raseljena lica, primorana da napuste svoje sredine usled ugnjetavanja i kriminala, ratnih i drugih konflikata. Uzroci napuštanja zemlje porekla mogu biti i pogoršavanje ekonomsko-ekološkog kvaliteta života, posebno u Latinskoj Americi, Africi, Aziji i Evropi.

Rad je nastao u trenutku kada se upravljanje migracijama i policijski nadzor nad kriminalom spajaju u politiku „krimigracije“. Dakle, ovaj rad osporava rizična shvatanja među tržišnim činionicima da su legalne kolekcije antikviteta značajni izvori zarade i da su izbeglice sa legalnim ili ilegalnim kolekcijama značajni akteri u navedenom procesu. Kupovinom nedokumentovanih antikviteta, postoji mogućnost i za finansiranje nasilnih političkih organizacija.

Organi za sprovođenje zakona, kao i organi za upravljanje migracijama trebalo bi da svoj rad organizuju tako što će zaštititi one koji zakon krše u cilju preživljavanja i iskoristiti informacije koje oni poseduju protiv nasilnih političkih organizacija koje podstiču raseljavanje.

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ARCHAEOLOGICAL RECORDS AS EVIDENCE OF SOCIAL DIFFERENCES: THE DEDICATORS OF ROMAN EPIGRAPHIC MONUMENTS IN THE VICINITY OF THERMAL SPRINGS IN SERBIA

ABSTRACT

Thermal springs have always represented a prominent feature in a geographical and social environment and, especially during Antiquity, their presence was often a stimulus for the development of settlements and sanctuaries. Regarding the Roman epigraphic monuments found in the surroundings of thermal springs in Serbia, which are nowadays still associated with health resorts, there are only a modest number of examples. On this occasion, we analysed their inscriptions, which, along with the materials of production such as porphyry or marble, show that the dedicators were mostly members of the upper social class, from the ranks of state officials (Mediana), beneficiarii consularis (Novopazarska Banja) or priests (Kuršumlijska Banja). Nevertheless, this certainly does not exclude the possibility that members of the lower social categories also used the therapeutic properties of water, probably worshipping the same iatric deities, which raises the question as to how suitable the reconstruction of phenomena like these religious-health practices places may be using only such material remains.

KEYWORDS: DEDICATORS, SOCIAL STATUS, ASCLEPIUS, THERMAL SPRINGS, IATRIC DEITIES, ROMAN CULTS.

INTRODUCTION

Although, from an archaeological perspective, the discoveries of material culture cannot be used to reconstruct the physical context itself as a frame for the establishment of social relationships, they can still be perceived as the materialisation of certain components of the social past. This is particularly evident when examining cultures with long continuity that have been exposed to traditional models of behaviour, implying that the advancement in social status is necessarily reflected through the materialisation of higher quality. On this occasion, an example of such social diversity in the Roman Empire can be found through the

analysis of the status and function of the dedicators of votive monuments in the surroundings of the thermal springs on the territory of Serbia.¹

Thermal springs have always represented a strong feature in the geographical and social environment, and very frequently the presence of this type of spring was the stimulus for the development of settlements and sanctuaries (Croon 1967: 225–226). Among the ancient Greeks, the thermal

¹ We note that the topic “Social status of the dedicators of Roman votive monuments in the environment of thermal springs in Serbia” was presented by the authors of this paper at the conference “Serbian Archeology between Theory and Facts IX”, held at the Faculty of Philosophy in Belgrade in April 2022.

waters were considered sacred, and it was believed that the springs were protected by certain deities such as Asclepius and Hygieia, Heracles and Hephaestus, while evidence of the cult of Artemis and Apollo was also often recorded near such springs. The Romans accepted a similar practice, so the cults of healing deities were spread throughout the entire territory of the Roman Empire. One of the most popular was the cult of the god Asclepius, who was Romanised² in the Roman period and worshipped mainly in small and private temples (Љубомировић и Радуловић 2021: 140–148).

It is noticeable that a large number of dedications to Asclepius in the territory of the Roman Empire come from dedicators in military circles because they were not only connected with Asclepius through his healing powers, but also prayed to this deity in order to find lost items or to achieve victory (Renberg 2007: 116–117). Additionally, despite Asclepius' primary role to ensure or recover the health of his worshipers, he was at the same time the protector and guardian of households, and seen as the protector of the emperor's well-being as well as his entire family (Edelstein and Edelstein 1998: 104). This could be one of the reasons why the dedications to him, as well as to other deities that are generally located near healing thermal springs, came very often from upper social class dedicators.

ROMAN EPIGRAPHIC MONUMENTS FROM THE VICINITY OF THERMAL SPRINGS ON THE TERRITORY OF SERBIA

Regarding the Roman epigraphic monuments found in the surroundings of thermal springs in Serbia, which are nowadays often associated with modern spa resorts, there are just a modest number of finds: two votive statuettes with inscriptions from *Mediana*, and votive monuments from Krupac, Novopazarska Banja and Kuršumlijska Banja (Figure 1).

² It is believed that the cult of Asclepius reached Rome in 293 BC because of the need to cure people from the plague and to stop the further spread of the disease. Consequently, Sibyl's oracle was consulted, which suggested building a temple dedicated to this new deity in Rome (Edelstein and Edelstein 1998: 185).



Figure 1. Thermal spring sites in Serbia where votive reliefs were found (map by Nataša Miladinović, National Museum Kruševac).

Inscriptions dedicated to iatric deities from Mediana

The site of *Mediana* was certainly connected to the healing springs in the nearby Niška Banja, and the users of the thermal baths within the palace complex probably benefited from this healing water, which was easy to transport thanks to the natural fall of the terrain (Љубомировић и Радуловић 2021:152).³ As support to this claim, there are numerous finds of monuments dedicated to iatric deities, among which two porphyry statuettes, votive gifts to Asclepius and Hygieia, stand out (Figures 2 and 3).⁴ Unfortunately, both are

³ Based on archaeological material, it was confirmed that the thermal springs in Niška Banja were probably in use since the time of Antoninus Pius (Јовановић 1975: 63).

⁴ Representations of Asclepius and Hygieia were also found on the bronze railing discovered during the archaeological excavations of *Mediana* in 2000. It is assumed that it was brought on the orders of Emperor Julian, who was a great admirer of the god Sol (Helios), as well as Asclepius, during his stay in *Naissus* in 361. The part of the railing that was found during excavations had probably been hidden in 378 due to the invasion of the Goths (Vasić 2004; Vasić



Figure 2. Statuette of Asclepius, from *Mediana* (Narodni muzej Niš 2023a).



Figure 3. Statuette of Hygieia, from *Mediana* (Narodni muzej Niš 2023b).

fragmentarily preserved, so Asclepius is lacking a head and part of one arm, while being preserved at a height of 43 cm. His figure is bare-chested, covered from the waist with a long dress and a cloak draped over the back, while sandals with straps can be seen on the feet. The rectangular base of this statuette has a Greek inscription dedicated to the mentioned deity by a certain *Roimetalcus*

and his wife *Philippa*.⁵ The statue of Hygieia was also made of porphyry and discovered in a fragmented state at a preserved height of 46 cm, with a dedication in Greek. She is dressed in a long dress with a cape over it while a snake is wrapped around her right arm. The Greek dedication on the statue's base is devoted to Hygieia and mentions the same dedicator as on the Asclepius statuette⁶ (Јовановић, 1975: 57, 60; Vasić 2018: 94–95, 97).

Regarding the base inscriptions of these statuettes, it was pointed out that the name itself and the Greek language of the dedication certainly indicate that these sculptures originate from the territory dominated by the Thracians (Јовановић 1975: 60). They may have been brought to *Mediana* for a specific reason, possibly for a sanctuary dedicated to Asclepius during the reign of Julian, though they were made in Egypt earlier, probably during the Tetrarchy period (Vasić 2018: 97, 105).⁷ Similar dedications to Asclepius and Hygieia are rarely found in the Roman Balkan provinces, while in the period of Late Antiquity, they were widespread in eastern Greece but not frequent in the western provinces (Petrović 1979: 9596, no.59; Марин 2003: 63).⁸ The title of the dedicator on these sculptures indicates that he was of an upper social status, perhaps a high-ranking official in imperial service (Petrović 1979: 97, no. 61).⁹ Additionally, since the name *Roimetalcus*, as well as his title, were erased from Hygieia's statuette, it is considered that he could not be the owner of the villa in *Mediana*, but that the owner himself wanted to perform a kind of *damnatio memoriae* in order to use these sculptures in the newly established sanctuary (Vasić 2018: 97, note 56).

⁵ According to the reconstruction of P. Petrović (1979: 95, no. 59) it can be read as follows:

Σωτήρι Ἀσκληπιῶ Ροίμητάλκης καὶ ἡ σύμ | βιος Φιλίππα
εὐ | ξάμενοι ἀνέθηχ[αν]

⁶ The text of the inscription is: Υγιείᾳ Ροίμητάλκης | ὁ διαση(μότατος) καὶ ἡ σύμβιος Φιλίππα εὐξάμνηοι
ἀνέθηκαν (after Petrović 1979: 97, no. 61).

⁷ This can be confirmed by the palaeographic characteristics of the inscriptions (Petrović 1979: no. 59, 61).

⁸ Sculptures depicting Asclepius and Hygieia are also rarely found in the territory of Upper Moesia (Tomović 1993: 95, no. 101, 96, no. 107, 97, no. 109, 117, no. 185).

⁹ In previous literature, it has been discussed whether the dedicant of these statuettes could be identified as *Valerius Rometalca, dux Aegypti*, but this has largely been dismissed (Vasić 2005).

The votive relief from Krupac

The mound in Krupac was first explored at the beginning of the 20th century, but no significant discoveries were made at that time (Васић 1910: 270, 273). In later literature, the Mogila tumulus from Krupac was mentioned in connection with the finds of Roman bricks, but special attention was drawn to the finding of a votive relief with a representation of two Thracian riders (Петровић 1966: 250; Тонев 1933: 316–317; Геров 1969: 169, 183; Георгиев 1977: 68). In the documentation of the Museum of Ponišavlje, it is recorded that it was found in 1953, while its exact location is registered as the so-called Krupačko blato (*eng.* mud) i.e., the southern side of the Krupačko lake, which is located in Veliko selo (Пејић 2015: 202, фус. 28). It is also important to note that the remains of Roman buildings, parts of water and sewage pipes, mosaics and other movable archaeological material was discovered near the location of this relief.

It is a votive plate made of fine-grained marble, quadrangular in shape with a length of 34 cm, a width of 25 cm, and a thickness of 4 cm. In the bordered upper field, one can see a scene made in shallow relief showing two figures on horses in motion, facing each other. The horsemen are dressed in chitons that flutter behind them, while both figures hold a flat object in their left or right hands (*patera?*). Between them there is a tree with a snake wrapped around it, while under it there is an altar (Figure 4). On the lower part of the plate below the representation of the deities, there is a three-line inscription in Greek.¹⁰

From the inscription we can discover that *Gaius*, the son of *Proclus*, dedicated this votive relief to Apollo and Asclepius with the epithet *Berakel-nos*, fulfilling the given vow, which confirms that the two riders represent the aforementioned deities (Гавриловић-Витас 2021: 179; Вељковић и Васиљевић 2022: 4). In the opinion of P. Petrović, this relief is an example of the cult syncretism of the Dioscuri and the Thracian horseman, because the inscription is dedicated to the iatric deities



Figure 4. Votive relief, from Krupac (Muzej Ponišavlja Pirot).

Apollo and Asclepius, while the Dioscuri were also given significant healing powers (Петровић 1964–1965: 250).¹¹

The epithet that appears in the dedication – Βερακελήνοις, represents a unique example that has not been discovered on any other monument to date. According to the analogy with the find from the Glava Panega site in Bulgaria, the second part of the epithet Βερακελήνός i.e., κελήνός, could mean “to flow, spring up” (Петровић 1966: 250).¹² Therefore, it was assumed that this epithet was in connection with the ancient name of the settlement, as a toponym related to a thermal spring, namely a spa used in the Roman period (Петровић 1966: 249; Јовановић 1980: 7). This is supported by the previously mentioned presence of water and sewage pipes as possible proof of the use of the water from the thermal spring, while the votive plaque, dedicated to iatric deities, testifies to the cultic importance of this place.

The votive altar from Novopazarska Banja

Novopazarska Banja is located on the main

¹⁰ According to the reconstruction of P. Petrović (1966: 249–250) it can be read as follows:

Ἀπόλλωνι καὶ Ἀσκληπιῷ Βερακελήνοις Γάιος Προκλου
εὐξάμενος ἀνιθῆρι

¹¹ In the western area of Philippopolis, dedications to gods with such a meaning are very common, while the most significant sanctuary of the Thracian rider in the area of Philippopolis is the one in Batkun, where around 250 votive reliefs and statues dedicated to Asclepius were found (Boteva 2011: 86).

¹² Βερακελήνος can also mean “white spring” (Georgiev 1975: 25–26; Георгиев 1977: 49, 68, 178); Likewise, a new interpretation of this toponym was recently based on the Thracian translation for “dark spring” or “muddy spring”, since the mentioned thermo-mineral spring is located near the Krupac swamp, which is created by releasing water from it (Вељковић и Васиљевић 2022: 9).

road from Belgrade via Novi Pazar to Adriatic coast, 3 kilometres northeast of Novi Pazar. Within the settlement there are several thermo-mineral springs, belonging to a group of sulphur baths (Гајић 2003). The remains of two smaller temples were discovered there (Јовановић 1995: 62–63), which are directly connected to the nearby mineral springs and the older sacral tradition of this place. Several votive monuments were also found, of which the most important is one dedicated to Jupiter and the local genius of mineral springs (Марић 1954–1955: 357–358). This monument was made of sandstone, with the following dimensions: height 84 cm, width 32 cm, thickness 28 cm. It is profiled and decorated with carved representations of vine leaves and today is kept in the National Museum in Kragujevac. It is dated to the end of the 2nd century. Its dedicator is mentioned as *Marcus Ucentius, beneficiarius consularis* of the legion VII *Claudia*.¹³

Regarding this dedication, the question of the local deity that was revered here, possibly with certain iatric properties, may remain open. Also, there is the dilemma as to whether the dedicator himself, who probably served there, was well acquainted with the local cults or not.

The votive altars from Kuršumlijska Banja

Kuršumlijska Banja is a town settlement and spa resort in the administrative district of Toplica, with several sources of carbonated mineral water (Бојовић 2010: 214–215). Roman bricks and walls, as well as a silver *denarius* of Emperor Philip the Arab, were found there during the construction of the bath at the end of the 19th century (Ризнић 1884: 83).¹⁴ In 1884, a votive monument was discovered near Kuršumlijska Banja, in the cemetery of the village of Bunjaci, which was later transferred to the lapidarium of the Na-



Figure 5. Votive relief, from Kuršumlijska Banja (after Вулић и Премерштајн 1900: 25).

tional Museum in Belgrade (Валтровић 1884: 12; Premerstein und Vulić 1900: 127).

It is a votive altar dedicated to healing nymphs, protectors of thermal springs (**Figure 5**).¹⁵ The altar is made of grey tuff, with the following dimensions: height 80 cm, width 41 cm, thickness 37 cm, with the inscription field measuring 47 by 37 cm. According to one opinion, the monument could have been made at the beginning of the 3rd century, while the dedication to the nymphs clearly indicates that the thermal springs were used at the time of the Romans (Вулић и Премерштајн 1900: 25). Additionally, the dedicator of the monument, *Catius Celer*, who devoted the monument together with his wife and sons, was probably the *pontifex* of Ulpiana. However, there is a different opinion regarding the dating, whereby the monument is connected to the reign of Gordian III, de-

¹³ The inscription text reads as follows (after Марић 1956: 357–358):

I(ovi) O(ptimo) M(aximo) ceterisque dis deabus huiusce loci pro salute domini(i) nostril M. Ucentius b(ene)f(iciarius) c(onsularis) l(egions) VII Cl(audiae) v(otum) s(olvit)

¹⁴ The importance of these thermal springs during Antiquity is represented by an epigraphic monument dedicated to *Dea Dardanica*, which was discovered in 1937 in Kuršumlijska Banja. Its inscription confirms the name of the Roman settlement in Kuršumlijska Banja, in the abbreviated form as *Aquar(um) Bas...* (Petrović 1995: 104).

¹⁵ According to Premerstein and Vulić (1900:127), the reconstruction of the text reads as follows:

Nymphis Salutaribus [...] Catius Cele[r] pontifex (?) [2-3] [L]ucilla coiug(e) [et] Lucio et Sexto (!) filiiis

terminated in the second quarter of the 3rd century (Јовановић 2003: 36). Additionally, there was an assumption that the dedicator might have been related to *Lucius Cattius Celerus*, a state officer of high rank who erected the monument in honour of Gordian in *Timacum Minus* in 242, on behalf of the II Dardanian cohort. However, as his name was not recorded elsewhere, that connection at first remained hypothetical. Still, the final confirmation that it is the same person was provided by the discovery of a milestone from the area of *Ad Fines*, found in 1875 on the threshold of the church of St. Nikola in Kuršumlija. The inscription bears the name of *L. Cattius Celer*, with the title that belongs to him, *legatus Augusti propraetore* (Петровић 2007: 92–93).

CONCLUSION

From the above-mentioned considerations, it can be noted that the Roman inscriptions in the vicinity of thermal springs in Serbia indicate how the benefits of healing waters were primarily used by members of the upper social ranks. Through such monuments, they probably expressed gratitude to the deities whose patronage enabled their healing or good health. Consequently, most of the dedicators whose social status was recorded on these monuments, as a rule, belonged to state officials (*Mediana*), *beneficarii consularis* (Novopazarska Banja), or priests (Kuršumlijska Banja).

However, this certainly does not exclude the possibility that members of the lower social categories used the therapeutic benefits of thermal springs as well, probably worshiping the same iatric deities. Therefore, given that these places are typically associated with cults in the literature, the question arises as to how appropriate it is to recreate phenomena like these religious-health practices through such material remains. Moreover, this can be additionally indicated by the fact that most authors agree that the cult of Asclepius enjoyed exceptional popularity because all people, regardless of race, social status or age, were welcome in his sanctuaries, as well as that the cult of this deity embodied constant benevolence towards people who would turn to him for help (Wells 1998: 15).¹⁶ In addition, it is necessary to

ask to what extent it is even possible to understand the cultic practice related to the respect of deities and their iatric properties in the environment of thermal springs in our territory, since no other typical finds, like votive gifts in the form of diseased body parts, have been recorded in the mentioned places (Vasić 2018: 98). In our opinion, the only appropriate method to gain a more detailed insight into the healing practices in these specific sites is to insist on the relevant archaeological context as the proper source of concrete knowledge.¹⁷ We believe this is a very important issue that should be given more attention in further studies of similar phenomena in Roman culture.

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also medical care centres (Garantzioti, Nikolaos and Manoutsoglou 2019: 530).

¹⁷ This issue is complicated by the fact that, except for the finds from *Mediana*, the presented monuments were not found during systematic archaeological excavations. These are mostly monuments published in older literature that provided scarce information about the conditions of their discovery. In this case, it is certainly necessary to re-examine whether it is possible to talk about existing cult places with organised rituals or if it is a question of isolated dedications. One of the possible solutions for this could be a future revision of the results of all conducted archaeological campaigns in their immediate or wider surroundings, as a possibility for a closer reconstruction of their exact context.

¹⁶ The Asclepieia were not only temples of worship but

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REZIME

ARHEOLOŠKI ZAPISI KAO SVEDOČANSTVA SOCIJALNIH RAZLIKA: DEDIKANTI RIMSKIH EPIGRAFSKIH SPOMENIKA U BLIZINI LEKOVITIH IZVORA U SRBIJI

KLJUČNE REČI: DEDIKANTI, DRUŠTVENI STATUS, ASKLEPIJE. LEKOVITI IZVORI, IJATRIČKA BOŽANSTVA, RIMSKI KULTOVI.

Iako otkrića materijalne kulture ne mogu rekonstruisati sam fizički kontekst za uspostavljanje socijalnih relacija, mogu se percipirati kao emanacija određenih komponenti društvene prošlosti. Na primeru kultura koje su, poput rimske, dugo trajale i obilovale tradicionalnim modelima ponašanja, posebno je uočljivo da se napredovanje u društvenom statusu uglavnom iskazivalo kroz materijalizaciju višeg kvaliteta. Upravo takvo društveno raslojavanje u Rimskom carstvu ovom prilikom smo sagledali analizirajući položaje dedikanata spomenika posvećenih ијатричким бојанствима u okruženju lekovitih izvora na teritoriji Srbije.

Naime, postojanje lekovitih izvora oduvek je davalo snažan pečat geografskom i društvenom okruženju, te je tokom antičkog perioda prisustvo ovog tipa vrela često predstavljalo podsticaj za razvoj naselja i svetilišta, ponekad sa lečilištima. U pogledu rimskih epigrafskih spomenika, nađenih u mestima koja se i danas dovode u vezu sa banjama na našem tlu, radi se o nevelikom broju primeraka: dve statuete sa natpisima iz Medijane, zatim jednom spomeniku iz Krupca, kao i votivnim arama iz Novopazarske i Kuršumlijske Banje. Njihove posvete, uz materijale izrade kao što su porfir i mermer, otkrivaju da su ovde dedikanti uglavnom bili pripadnici viših društvenih slojeva iz redova državnih (carskih?) činovnika (Medijana), beneficijarnih konzulara (Novopazarska Banja) ili sveštenika (Kuršumlijska Banja). Takva situacija, međutim, svakako ne isključuje mogućnost da su i pripadnici nižeg socijalnog statusa koristili lekovitost vode i poštovali iste bogove ијатричког карактера. Usled toga, nameće se pitanje koliko je rekonstrukcija fenomena poput

ovakvih religiozno-zdravstvenih praksi putem pomenutih materijalnih ostataka zapravo adekvatna, budući da se u literaturi ta mesta uglavnom označavaju kao kulturna. Na to dodatno može ukazati i činjenica vezana za poštovanje boga Asklepija, koja govori da se većina autora slaže da je izuzetna popularnost njegovog kulta zasnovana na tome da su svi ljudi bez obzira na rasu, socijalni status ili godine bili dobrodošli u njegovim svetilištima, odnosno da je kult ovog božanstva tradicionalno činila benevolentnost prema ljudima kojima je bila potrebna pomoć. Aktualizaciju tog problema naglašava i to što na ovim lokalitetima za sada nisu nađeni i drugi votivni darovi tipični za poštovanje pomenutih božanstava u datom okruženju. Stoga smatramo da je insistiranje na odgovarajućem arheološkom kontekstu, posebno u pogledu nekih budućih istraživanja, trenutno jedini put ka nešto pouzdanijim saznanjima o takvim kulturnim praksama na našoj teritoriji.

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THE LOOK THAT CAN PETRIFY: ANCIENT SPOLIA WITH MEDUSA MOTIF EMBEDDED IN SACRAL BUILDINGS ON THE TERRITORY OF SERBIA

ABSTRACT

The motif of a Gorgon i.e., Medusa, with prominent curls of hair and snakes wrapped in a Hercules knot, was very widespread in ancient Roman art. Inspired by the myth, Medusa's appearance was initially terrifying, but over time it changed and transformed into a representation of a beautiful young woman. Her apotropaic role in art was highlighted, but the Gorgon possessed both a prophylactic and astral character. Medusa as a protector transferred from the ancient pagan culture to the time of Christianity, as part of which her representations also appeared on spolia. Among them are funerary monuments built into the medieval monasteries of Rukumija, Nimnik, and the Church of the Assumption of the Blessed Virgin Mary in Smederevo. Interpreted by the people, the three built-in spolia with the depiction of Medusa became the protection of these sacred buildings.

KEYWORDS: MEDUSA, GORGON, MYTHOLOGY, ANTIQUITY, PROTECTION, MIDDLE AGES, SPOLIA, SACRAL BUILDINGS, FOLK TALE.

INTRODUCTION

Medusa was the archetype of the “femme fatale”, whose destructive nature was expressed in her contradictions, and she was, at the same time, feminine but violent, beautiful but terrible, and represented eroticism but also death itself (Karoglou 2018: 4-5). Her representation in the form of a hybrid had the power to ward off evil and intimidate enemies, however, Medusa's apotropaic function was particularly prominent and significant (Milovanović and Anđelković Grašar 2017: 167).¹ Due to the similarity in appearance, the origin of the Gorgon was associated with the Neolithic snake goddess who symbolised, like Medu-

sa, birth, life, death, and rebirth, which was the reason for the appearance of the Gorgon's image on funerary monuments, ritual places of rebirth or, as described in the words of Miriam Robbins Dexter: “The tomb was also a womb” (Dexter 2018: 472).

With her mortality and a dangerous look that had the power to petrify, Medusa represented the embodiment of the harsh truth that death is an inevitable aspect of life, and her figure decorated and protected many funerary monuments of Roman art (Karoglou 2018: 8, 12), while it was one of the most represented decorative ornaments on the funerary stelae of the Roman provinces, especially around the year 100 (Dautova-Ruševljan 1983: 46). Examples of such funerary monuments were used as spolia by embedding them in the walls of medieval sacred buildings in the area of the Central Balkans, which will be the subject of this research. This paper aims to use mythological

¹ A hybrid is a being that was considered an anomaly, created from a mixture of human and animal body parts, as well as their characteristics. They were introduced to Greece from the Near East and Egypt during the 8th and 7th centuries BC.

and folk stories, as well as the characteristics and properties attributed to Medusa, to point out her role in the funerary context, as well as the importance of the reuse of ancient monuments in later construction.

THE ORIGINS OF THE MEDUSA MYTH

Medusa's name is formed by shortening Poseidon's title "Eurymedon", in other words, "the wide ruling one", into a feminine form that denotes epithets such as goddess, protector, or Medusa (Howe 1954: 214), while the term "gorgos" is translated from the Greek language as dreadful, dire, and atrocious. The myth of the Gorgon enjoyed popularity in ancient and Christian times, but its roots go back to the European Neolithic era, and can also be recognised in Indo-European iconography and mythology (Dexter 2018: 463-464).

The inspiration for certain elements of the Medusa myth were found in "The Epic of Gilgamesh", more precisely in the character of the demon Humbaba who was defeated in battle by the Sumerian king and hero Gilgamesh by cutting off his head. In addition to the same tragic death and protective role they both had, Medusa's representation in art finds a prototype in the appearance of Humbaba's head (Dexter 2018: 473-474). Nevertheless, Homer's "Iliad", which dates from around 750 BC, contains the first mention of the Gorgon in literature when describing the aegis of the goddess Athena and Agamemnon (Leaf 1900: 5.741-42, 11.36-11.37).² The terrifying appearance of the mythological creature could frighten the enemies, so shields decorated with her image were rich in Greek iconography (Dexter 2010: 26). In the description of the Trojan hero Hector, in the same literary work, Medusa's eyes are also shown as eyes that petrify and bring evil (Homer 2013: 8.349), while in Homer's "Odyssey", the Gorgon is described by Odysseus himself as a terrifying creature that resides in the Underworld (Dexter 2018: 465). Then, in Hesiod's "Theogony", the book talks about Steno and Euryale, the immortal sisters of Medusa, while she is described as a mortal and terrifying being, and at the same time an attractive young girl who mesmer-

ised the god Poseidon with her beauty. Also, in the same text, there is the first mention of Perseus beheading Medusa, after which the man with the golden sword, Chrysador, and the winged horse, Pegasus, are born (Solmsen, Merkelbach and West 1970: 270-281). The story of Gorgon also found a place in the literary pieces of authors such as the Greek poet Pindar, who significantly changed her description by attaching locks of serpents to Medusa's hair (Dexter 2018: 466-467), the Greek historian Herodotus (Hude 1908: 2.91) and Diodorus Siculus who connected the mythological being with Libya (Dindorf 1866: 3.55.3).³ Medusa appears in the play "Ion" by the tragedian Euripides, attached to the walls in the form of an antefix, where her apotropaic role was emphasised, considering that she guards the temple as well as buildings of different purposes (Dexter 2018: 467). In the same play, the Gorgon's blood is mentioned, which has the power to recover from illness and, at the same time, it can be deadly (Murray and Diggle 1913: 1003-1005), while from Apollodorus, in the 2nd century BC, it can be learned that her blood can save or destroy humanity (Hard 2008: 2.4.3, 3.10.3). Medusa's blood is like the poison of a snake, it is both a poison and its medicine at the same time, and Medusa herself represents both death and regeneration (Dexter 2018: 468). A significantly different story about the Gorgon than the one recorded by Hesiod in his "Theogony", which is still known today, is presented by the Roman poet Ovid. He provides us an insight into the story of the transformation of a beautiful woman into a serpent-haired Gorgon, as well as Perseus' slaying of her with a mirror, which he used so that he could see and avoid the power of her gaze (Humphries 1960: 4.617-20, 4.779-86, 4.794-801). It is notable that both Greek and Roman writers believed in the apotropaic power and dual role of the Medusa (Dexter 2010: 32).

THE DEVELOPMENT AND USE OF MEDUSA'S DEPICTION

Medusa, an important aspect of ancient iconography, was also considered a significant deco-

² The aegis is a shield.

³ The literary piece by Pindar is named "Pythia" and it dates back to 500 BC. The work of Diodorus Siculus dates back to the middle of the 5th century BC.

rative-ornamental element, which conditioned the adaptation of its appearance to suit the taste of the craftsmen who created it as well as their patrons (Jeremić 2017: 256, 259). At the beginning of the 5th century BC, the monstrous creatures of the archaic period were humanised and rationalised under the influence of the beauty standards of ancient Greece.⁴ During the Classical and Late Classical periods of Greek art, Gorgon's appearance changed, she underwent feminisation and her animalistic features softened, and she became an attractive young woman, with a noticeable influence of the archaic period. The composition with many new elements, which is considered the first beautified representation of Medusa in the art of Greece, is known as Medusa Rondanini. The altered depiction adorned with subtle, small wings on her head and a pair of snakes tied in a knot below her neck remains the embodiment of a tragic figure, who was both the aggressor and victim (Karoglou 2018: 3, 5, 7, 9, 11, 14, 16).

Medusa's mesmerising gaze attracted attention but, at the same time, it posed a danger to any onlooker. The ability to look at the Gorgon's depiction without becoming petrified signifies that the viewer is immune to her powers and thereby becomes aware that Medusa is a representation, rendering her harmless. "Can represent the dangerous without endangering, the harmful without harming, the desirable without satiating" (Grethlein 2016: 100). A potential joke is created when depicting the Gorgon in works of art where she is made of stone - instead of the viewer, the Gorgon herself is petrified (Elsner 2018: 360).

During the Roman era, Medusa's image became a decorative element of numerous architectural buildings, such as temples and villas, but also objects of applied art, military equipment (belts and armour), weapons (shields), and oil lamps where, in addition to its ornamental and prophylactic character, its apotropaic function could also be seen. According to the myth, Perseus gave the head of the Gorgon, or Gorgoneion, to Athena/Minerva, who placed it on her shield. Gorgoneion, a representation of the head, bust, or mask of Medusa whose symbolic meaning is linked to the

expression and overcoming of subconscious fears such as the fear of natural disasters and animals, belongs to a group of demon depictions (Jeremić 2017: 255-256). The prevalence and popularity of the representation of this mythical creature was evidenced by the fact that the Romans created a Medusa cult for women who wore jewellery with her motif and believed in Medusa's protective power.⁵ For respectable Roman matrons, jewellery decorated with the image of the Gorgon was a symbol of divine female wisdom and a protector of women, it shunned unwanted glances and immoral behaviour and also had the function of an amulet, which made it very common and often worn. Jewellery with the representation of Medusa was found stored in the tombs of the necropolis of Viminacium, which indicates that, in addition to the protection of women, she was also associated with the perception of the afterlife (Milovanović and Anđelković Grašar 2017: 168-173, 175, 178).

The Gorgon representation, the emblem of suffering and death, was also used as a decoration for sarcophagi, urns, and funerary stelae (Frothingham 1915: 13). The reason for erecting a monument can be interpreted in several ways, but among the Romans who were familiar with the saying "Mors janua vitae", there was a fear of transience and that the deceased would fall into oblivion. They strove to use motifs that symbolised the phenomenon of dying and birth to create a vision of the world in which the souls of the deceased resided eternally (Milovanović 2001: 109). Also, anxiety and concern for the safety of the grave were present and, due to the need for protection, Medusa's figure appeared on them, which, with its apotropaic purpose, replaced the rosette, a favourite motif in the tympanum of the Noric-Pannonian stelae. On them, physiognomic similarities between the Gorgon and certain deceased individuals were observed, which indicates their intimacy with possible eschatological adulterants (Gregl and Migotti 1999: 155).

According to the beliefs of the Roman civilisation, the dead represented a greater threat to the living, and funerary monuments did not depict a terrible and sinister Gorgon, but a mythologi-

⁴ According to Kiki Karoglou, an integral part of the beauty standards of ancient Greece was harmony and proportion (Karoglou 2018: 3).

⁵ The Gorgon motif could be found on rings, cameos, lockets and earrings.

cal being with a sometimes worried, sometimes frowning, but essentially beautiful face. Medusa's role was based on her chthonic-astral qualities, and the Gorgon's character, especially in Late Antiquity, was associated with the Sun and the Moon (Gregl and Migotti 1999: 155-156). Medusa's head can possess solar roundness (Frothingham 1915: 16), as well as productive and destructive energy, and was considered an emblem of the Sun's disc. However, its representation resembles the Moon and, together with its prophylactic and apotropaic character, was associated with the lunar cult. According to Orphic interpretations, Medusa was presented at the entrance to Hades, and since Pythagorean teachings state that Hades was located on the Moon, in addition to being a lunar symbol, the Gorgon had the role of encouraging mortals on their way across the ocean to the Isle of the Blessed (Milovanović and Anđelković Grašar 2017: 167-168). With the added astral character, in which capacity it began to decorate funerary monuments, Medusa remained an important motif, weather with ornamental or symbolical connotations.

THE USE OF ANCIENT SPOLIA WITH THE REPRESENTATION OF MEDUSA IN THE MIDDLE AGES

As an eternal reminder of the defeat of pagan ideology, the victory of the church, and the glorification of the new religion, the phenomenon of using ancient spolia in the Christian context was very common. However, the changes to the ancient forms in the evolutionary process that they went through in contact with influences and Christianity itself are noticeable. Among them is the Gorgon, which was utilised in the time of Christianity because of the decorativeness of its representation, the continuous belief in its protective role, or, simply, the popularity of the motif (Milovanović and Anđelković Grašar 2017: 177-178).

There are several known uses of spolia with Medusa's image in Christian times on the territory of Serbia and one such example was built into the upper part of the outer wall of the Small Town of the medieval Smederevo Fortress, more precisely on the second tower to the left of the entrance. It is a stela from the Roman province of Upper Moesia, from the 2nd or the beginning of the 3rd

century AD, which most likely belongs to a group of monuments from Viminacium.⁶ The relief of the monument depicts the mythological story of the Return of Alceste, dedicated to the love and sacrifice of Alceste who died in place of her husband Admetus (**Figure 1**). The scene consists of a male figure with a lion's skin draped over his shoulder and a club in his hand, representing Hercules, while with the other hand he holds the hand of a veiled female figure, representing Alceste, whom the hero brings out of the Underworld. On the right is depicted a female figure standing behind a chair and Admetus, depicted in mourning. Based on the symbolism, it can be concluded that the sepulchral monument is dedicated to a woman who died before her husband, and the key theme is conjugal love. Regardless of the poor preservation of the portraits of the depicted figures, it is noticeable that it is the work of a skilled artist and that it possesses a few characteristics of provincial art, in which it was common to depict the described mythological scene (Pilipović 2007: 76-81). On the frieze of this architectural-type marble stela, below the scene of the Return of Alceste, wild animals, more precisely a hunting scene, are depicted. The upper part of the spolia, i.e., the tympanum, is decorated with the protectress of this monument, Medusa, with luxurious hair and two hippocampi flanking her (Pilipović 2006: 337-338, 341). Although displaced from its original context, the described monument retains its essential, apotropaic role, as indicated by the displayed Gorgon's head.

However, with the change of circumstances, the ancient spolia acquired a new meaning (Вранешев и Шпехар 2019: 34), such as a female statue made of white marble, which was once situated in a specially walled niche of the first tower at the court entrance of the Small Town. The figure embedded into Smederevo Fortress was probably a sculptural work of the Viminaci-

⁶ Sanja Pilipović points out the fact that the creation of the monument to the Return of Alceste is attributed to a local, Upper Moesian workshop. It is assumed that the work was created in Viminacium or its surroundings, considering that the ruins of Viminacium were used as construction material for Smederevo Fortress. However, we should not ignore the possibility that the workshop of ancient Vinceia (near Smederevo) was also able to create a complex monument such as this (Pilipović 2007: 11, 76-77).



Figure 1. Spolia with a representation of the Return of Alceste, Smederevo Fortress (photographic documentation of the Institute of Archaeology, Belgrade).

um forum of the 2nd century AD, to which Leontije Pavlović adds the interpretation that it was a rare statue of the Greek goddess Hestia or the Roman Vesta (Павловић 1980: 153). In the statue, the people of medieval Serbia recognised the image of the Despotess Irene Kantakouzene, wife of the Despot Đurađ Branković, whose foreign origin was perceived in a negative context.⁷ Foreigners were characterised as evil, thus, in folklore the Despotess was described as an arrogant and damned woman, blamed for the political downfall of the Despotate. She was also credited with compelling people into forced labour, and in the desire to avenge the sufferings of their ancestors during the construction of Smederevo Fortress, “every good Serb had the duty to throw a stone” at the sculpture of the Roman goddess. The reason was the perception of the female figure as the Despotess, known among the people as the Damned Jerina, which caused the tower in whose niche the statue was placed to be named “Jerina's Tower” (Anđelković Grašar and Nikolić 2017: 100).

⁷ Irene Kantakouzene was Greek by origin.

Thanks to folk tradition, the Christian world accepted a pagan mythical being like Medusa (Николић 2018: 255). People interpreted myths and legends in many ways, which led to the creation of certain patterns and models in folk tales that served to explain various behaviours and phenomena (Anđelković Grašar and Nikolić 2017: 95). The same situation is noticeable in the myth and representation of Medusa, which, depicted on ancient spolia in the territory of the Central Balkans, is connected with Christianity and received a different purpose from the original one (Milovanović and Anđelković Grašar 2017: 176).

Church of the Assumption of the Blessed Virgin Mary in Smederevo

The foundations of the spiritual structure of the ideal vision of the medieval town were its sacral topoi, which for the last capital of the Serbian medieval state, the fortified city of Smederevo, was a church dedicated to the feast of the Assumption of the Blessed Virgin Mary. The church has been preserved in its entirety and is located

on the plateau of a small elevation known as Karađorđe Hill, southwest of the former medieval fortifications and integrated into the framework of the present-day Old Cemetery of Smederevo (Црнчевић 2007: 63, 68, 72).

According to the results of scientific research so far, there is not a single piece of information that would precisely establish the time of construction and painting, or the name of the founder, besides the epigraphical material that was engraved into the fresco-plaster or carved into the church's door and window sills. The mentioned inscriptions have different content and date from several time periods, the youngest mentions the year 1914, while the oldest is placed above the southern window of the nave, on which it is mentioned that the temple was built in 1012. In addition to numerous interpretations by researchers, Mladen Cunjak and Branislav Cvetković state that the engraved year does not indicate the date of construction of the church according to today's reckoning of time and that its meaning corresponds to the time of the 15th century, more precisely the first half or middle of the century (Цуњак и Цветковић 1997: 19-24). It can be concluded that the church was built during the construction of the nearby fortification, between 1428-1456, during the reign of the Despot Đurađ Branković (Спремић 2020: 122-149).

Considering the similarity of the materials and ornamentation used in the construction of the church and the medieval fortification, as well as the fact that no founding charter was found and that the founder remains unknown, many researchers associate the sacred building with the Branković family. More precisely, one of the assumptions about the original function of the Church of the Assumption of the Blessed Virgin Mary is that it was the eternal resting place of Đurađ Branković and his wife Irene with their sons (Црнчевић 2007: 17-18). Many researchers tried to fathom the answer to this complex question, and from certain literary works that describe the *translatio* of St. Apostle Luke's relic, it could be concluded that the incorruptible body of the Evangelist was kept in the church itself (Мано-Зиси 1951: 154). A different claim, namely that the church had the function of a burial chapel, made by Žarko Tatić, was supplemented with an explanation many years later (Татић 1930: 55-62). M. Cunjak and B. Cvetković state that the building was

used for cult purposes since Late Antiquity, which found its justification in the claim that during the First World War when the Germans found a pagan temple with a sculpture of the goddess Nike in the area of the cemetery. In addition, research and the discovery of a triconchal church within Smederevo Fortress led to the conclusion that there is a possibility that the Old Cemetery was created around the cemeterial building, i.e., early Christian martyrdom, and that the church was intended to maintain the continuity of the old cult. The presented thesis is complemented by the archaeological research of Mladen Cunjak, carried out in the inner space of the sacred building, when thirteen graves were discovered in the nave and the western passage. One of them, discovered in the nave, is particularly highlighted as a potential burial place of the bishop of the Smederevo diocese or Metropolitan Athanasius, and the burial of the grave dates back to the middle of the 15th century (Цуњак и Цветковић 1997: 11, 47). Dejan Crnčević adds to the previously stated, yet unconfirmed, cognitions, the most probable claim that, according to him, the building had the role of a monastery church.⁸ However, the original function of the Church of the Assumption of the Blessed Virgin Mary has still not been established with any certainty (Црнчевић 2007: 13-24).

In the hope of discovering more information about the origin of this sacred building, researchers rely on its stylistic and architectural characteristics. The time of creation, political circumstances, the ability of the architect and stonemason, as well as the economic power of the founder influenced the modest decoration and dimensions of the church. The architecture of the Moravian school of the late Middle Ages is indicated by the ground plan in the shape of a concise triconch (atrophied Greek-cross or cross-in-square plan) and a nave surmounted by an octagonal dome with a narthex. Based on the foundation of the sacral building, it can be concluded who the possible founder was, considering that the developed triconch churches were built by the rulers, while the concise type of churches were built by church dignitaries or landowners. The exterior facade of the Church of the Assumption of the Blessed Virgin Mary is made

⁸ The final research results are expected to be published in the PhD thesis of Dejan Crnčević.

of hewn stone blocks, partially pressed blocks, bricks in lime mortar and a cornice that divides it into two zones. The polychrome effect created by the material is enhanced by the shallow-relief plastic decoration in the form of two-part interlacing and geometric decorations on the door jambs and window sills (Цуњак и Цветковић 1997: 25-37). Among the decoration of the facade, two fragments of Roman funerary monuments stand out, built near the portal, one of which, with an inscription, is rotated by 90° in relation to the basic position, while the face of Medusa is shown in the tympanum of the other (Николић 2018: 253).⁹

Similar to the individual bricks with Roman markings that adorn the floor of the church, fragments of ancient Roman stelaе, integrated into the facade, are spolia. The nearby Smederevo Fortress also contains spolia made of the same materials and it is assumed that they come from Viminacium, Vinceia, Margum, or Aureus Mons. On the upper part of the funerary stele, made of fine-grained white marble and embedded in the northern part of the western wall of the Church of the Assumption of the Blessed Virgin Mary, the head of Medusa is shown flanked by two birds placed in the triangular fields of the monument (**Figures 2a and 2b**). The Gorgon is represented as a young girl, with an oval face and lush hair with clearly defined curls. However, due to damage, it cannot be confirmed with certainty that instead of certain strands of her hair, as in numerous other representations, snakes can be found that are tied into a Hercules knot under Medusa's chin (Milanović and Pilipović 2021: 264-265). The birds that frame the Gorgon's head, as on numer-

ous Pannonian monuments, suggest an eschatological rather than the usual, apotropaic function attributed to Medusa's representations (Gregl and Migotti 1999: 156). The described fragment indicates the possibility that the church was rebuilt during the time of Miloš Obrenović, similar to the Rukumija and Nimnik monasteries, whose walls were also embedded with ancient spolia (Цуњак и Цветковић 1997: 32).¹⁰

Rukumija monastery

The Imperial Chrysobull from 1018-19 describes the expansion of the Braničevo eparchy, but more information about the spiritual life there is obtained with the arrival of monks from Sinai, at the end of the 14th and the beginning of the 15th century.¹¹ The mentioned monks founded monastery churches around the caves where they practiced asceticism or at the places of their graves. Among the sacral buildings, the Rukumija monastery was built on the burial place of Saint Martyr. The preserved sources do not provide the exact year of construction of the monastery, nor the identity of its first founder, who is assumed to be one of the Sinaites (Цуњак 1996: 5-6, 8) or Prince Lazar, with whom the building was associated (Спасић 1996: 219).

The medieval monastery is located on the left bank of the Mlava, between the villages of Bradarac and Kostolac, together with the Church of the Holy Ascension. Its name is associated with the now-disappeared village of Rukomija, which was first mentioned, together with the monastery, in the Ravanička Charter of Prince Lazar (Николић 2018: 137). However, according to Leontije Pavlović, the name Rukumija is connected with the word “gerokomija” which, translated from Greek, means home for the elderly, while Olga Zrnojević makes a different assumption and identifies the medieval monastery of Rukumija with the Vrljište monastery.¹² A detailed description of the

⁹ Branka Vranešević and Olga Špehar define this phenomenon as the “desacralisation” of funerary monuments. When reusing and turning the monument upside down, it becomes “unreadable” in order to ensure easier control of the forces that resided in the monument. They can also act in favour of the person who is responsible for its installation (Вранешевеић и Шпехар 2019: 35). Jelena Bogdanović states that Christian relics were embedded in the buildings of Constantinople, while commemorative inscriptions and reliefs with crosses were placed in the city walls, and had the function of strengthening the sacredness of the city. She then draws an analogy between the architecture of the ideal Christian capital, Constantinople, and its “miniature copy, Smederevo”, in order to point out the rulers' aspirations for the continuity of their capital. (Bogdanović 2016: 106, 130-131).

¹⁰ Ljubomir Milanović and Sanja Pilipović oppose this claim and state that the implementation of the spolia happened earlier (Milanović and Pilipović 2021: 270).

¹¹ It is stated that the Braničevo eparchy extends on both sides of the Morava River, between the mountains Rudnik, Kotlenik, and Kosmaj, as well as the mountains that make up the watercourses of the Danube, Timok, and Mlava.

¹² Departments for the accommodation and treatment of



Figure 2a. Detail of the west facade of the Church of the Assumption of the Blessed Virgin Mary, Smederevo (photographic documentation of the Institute of Archaeology, Belgrade).



Figure 2b. Spolia with a representation of Medusa, Church of the Assumption of the Blessed Virgin Mary, Smederevo (photographic documentation of the Institute of Archaeology, Belgrade).

monastery itself was given in the year 1733, while the sacred building that M. Ratković conjured up was destroyed by the Turks in retaliation to the Serbian people during the suppression of the First Serbian Uprising (Цуњак 1996: 15-16). Later, in the year 1825, the monastery was restored by the “neimar” Janja Mihailović and Nikola Đorđević, on the orders of Miloš Obrenović, after which it became a lay church, the appearance of which was recorded by Joakim Vujić (Бојковић и Ђокић 2016: 103, 105).¹³ Also, J. Vujić, after visiting the monastery in 1826, noted that the building was razed to the ground and then rebuilt, while Mladen Cunjak claims that a part of the building was added, not the complete building. Confirmation of Cunjak’s assumption was found in the ancient Roman spolia placed on top of the southern wall of the church, which suggests that a fragment of the monument was embedded in the preserved height of the wall (Николић 2018: 138).

Today’s architecture of the Rukumija monastery includes a single-nave building with a semi-circular apse, a distinct altar space on the east side, and a narthex on the west side. The exterior facade, made of crushed stone in lime mortar, is decorated with two niches, two doors, and shallowly carved floral ornamentation in the semi-circular lintel, while the remains of architectural stucco and corniches are not visible (Цуњак 1996: 27, 32-33).¹⁴

A special note of uniqueness to the external appearance of Rukumija monastery is brought by the aforementioned marble spolia from the ancient era, built into the southwest corner of the south wall, under the cornice of the sacred building. On the pediment of a fragment of the funerary stele, the figure of Medusa is represented, facing the viewer, in shallow relief, flanked by a bird on the left and right side, while two horses with their riders are shown in triangular fields (Миловановић 2009: 101-102) (**Figures 3a and**

3b).¹⁵ Based on the decoration and the rusticity of the workmanship, the spolia of Rukumija is dated to the period between the second and the first half of the 3rd century AD, and it is assumed that it was brought from the territory of Viminacium. Literary sources about the monastery are scarce, so it is difficult to determine the exact time of integration of the Roman funerary fragment into the monastery wall. It is assumed that it was built during the restoration by Miloš Obrenović in 1825, but due to noticeable damage to the exterior, it is possible that it was built in and demolished together with the monastery several times (Спасић 1996: 222).

The monument fragment with horsemen and the Gorgon was an iconographic inspiration for a legend about the brothers Pavle and Radule and their sister Jelica, recorded in the folk song “God Settles All Scores”, which Vuk Stefanović Karadžić recorded and published in the second book of his songs (Цуњак 1996: 10, 14).¹⁶ In short, the legend takes place during the time of Prince Lazar and tells of Pavle and Radule Radić, two noble brothers, who lived near the monastery of Zaova with their families, including their sister Jelica. The harmony of the story is interrupted by Pavlovica, Pavle Radić’s wife, jealous of the attention and love that the brothers gave to their sister, committing a series of crimes for which Jelica is blamed.¹⁷ The brothers condemned Jelica for crimes she did not commit and tore her apart by tying her to the tails of their horses. Also, the poem records that Prince Lazar built churches in the places where Jelica’s body parts fell. The Zaova monastery was built on the place where her head fell, the Bradača monastery where her jaw fell, the Rukumija monastery where her hand fell, while the Sestroljin monastery, according to some sources, was built on the place where Jelica’s eyes fell (Anđelković Grašar and Nikolić 2017: 95), and according to others, on the place where her brothers tied her to the horses (Цуњак 1996: 12). Apart from Jelica’s hand influencing the origin of

old and infirm people were located within the larger medieval monasteries.

¹³ “Neimar” is a term used for architects of the time. Janja Mihailović and Nikola Đorđević are also known by the names Janja Mali and Nikola Cincar.

¹⁴ The niche on the western facade indicates the saint to whom the church is dedicated, St. Nicholas, since his icon is placed there. One door is located on the west side and the other on the north side.

¹⁵ Bebina Milovanović assumes that the birds are doves, carriers of the soul of the deceased, or personifications of the soul itself (Миловановић 2009: 101-102).

¹⁶ The original name of the song “God Settles All Scores” in Serbian is “Bog nikom dužan ne ostaje”.

¹⁷ Unpleasant events are listed in order of magnitude, so Pavlovica first killed her husband’s favourite horse and eagle, and then their child.



Figure 3a. View of the wall under the cornice of the south facade of the Rukumija monastery (photographic documentation of the Institute of Archaeology, Belgrade).



Figure 3b. Fragment of a funerary monument with a representation of Medusa, the Rukumija monastery (photographic documentation of the Institute of Archaeology, Belgrade).

the name Rukumija, it also represents an important relic of the monastery of the same name. Josif Veselić mentions this relic in his writings, around 1860, while Leontije Pavlović writes about the cult of Jelica, about Pavle who was called a prince and the legend of the creation of the four monasteries, according to which the Radić family, vassals of Prince Lazar, had in their possession Sopot Hill where their villa was located (Anđelković Grašar and Nikolić 2017: 96).¹⁸

Analysing the folk tale and the song, the presence of Christian influences can be assumed, while the basis of the story is of a much older, pagan origin. In the poem, there is a motif of sacrifice that arises from a myth as a reflection of ritual practice. Human sacrifice is necessary to ensure the fertility of the land, animals, and people. Additionally, sacrifices were made to strengthen buildings by incorporating body parts into the future creation. The blood of the victim creates a new life, while the body parts become the foundation of the sanctuary (Спасић 1998: 319-320), and the consequence of Jelica's death, in addition to the isolation of the heroine and her ritual death, is the transformation of her body into the foundation of the church (Бошковић 2005: 75-76). Vuk Karadžić's song was created without a specific historical background, but the influence of Eastern religions and cults can be seen in the conflicting principle of good and evil, a dualistic principle where Jelica is described as an example of goodness, while her sister-in-law, Pavlovica, is the embodiment of evil (Цуњак 1996: 12-14). The elements in the poem point to the demonic nature of Pavlovica, and when we add to the above that she was a woman without her own name, considering that the name Pavlovica originates as the feminine form of her husband Pavle's name, it is not unusual that her character is associated with the visual representation of Medusa on the Roman marble funerary monument built into the wall of the Rukumija monastery. Medusa, similar to Pavlovica, was presented as a demonic being that acquired more and more human characteristics over time, and this fact led to the folk legend and the association of Jelica and her two brothers with the ancient spolia, i.e., the depictions on it (Anđelković

Grašar and Nikolić 2017: 95-96). On the other hand, the presence of horses, psychopomps, and messengers of the gods in folk tales leads to the assumption that the legend is about a Chthonic deity. Given that Chthonic and fertility cults were connected, it can be concluded that Jelica's cult was about a lower Old Balkan deity of fertility, of Chthonic character, who was given a Serbian name, and the entire story was covered with the veil of Christianity (Спасић 1996: 224-225).

Misunderstanding of information led to folklore reinterpretations related to magic, supernatural, and mysterious forces, as well as the interpretation of the monument using folk tales that largely distanced it from its original function (Anđelković Grašar and Nikolić 2017: 96). The best example of this is the song "God Settles All Scores", which was created according to archaic, mythical models but, over time, those individual segments of mythical stories were lost. Individual motifs became symbolic while others were reimagined and, thus, a Christian moralistic story about the posthumous reward of the righteous was created by which the piece, like many others, was adapted to the given time and population (Бошковић 2005: 81).

Nimnik monastery

Near Požarevac, in the village of Kurjače, in the area of Stig, there is a medieval monastery of specific and obscure etymology - Nimnik. No literary sources have been found that would indicate the time of construction or the name of the founder, so researchers rely on the dimensions and architecture of the sacred building, as well as folk tradition for more information. According to one recorded by Joakim Vujić, the construction of the monastery is attributed to a nobleman, a contemporary of Despot Đurađ, Prince Bogosav. It dates back to the last decades of the existence of the independent Serbian state, until its fall in the year 1459. However, in the Ravanica charter, it is pointed out that Nimnik was built during the time of Prince Lazar and that it was a metochion of the Ravanica monastery. Nimnik, in other words, the Marian monastery, the Temple of St. Nicholas, is connected to the village of Marijani, where it was built, and which appears in historical sources such as the charter of the Hungarian king Sigismund in

¹⁸ According to Leontije Pavlović, the Radić family lived in Belgrade and spent their summers at the Sopot Hill villa.

the year 1428 and the written confirmation from 1428/29, of Despot Đurađ Branković on the right of ownership of certain villages to the great leader Radič Postupović. For this reason, in many documents, the monastery is inscribed with the name of the village (Бојковић и Ђокић 2016: 88-95).

According to M. Kolarić, Prince Miloš Obrenović rebuilt the monastery on the old foundations in 1821 (Коларић 1966: 24), while, according to D. Kašić, it was in the year 1825 (Кашић 1960: 270). Nimnik became a simple, rectangular building made of crushed stone, which was also used for the construction of a small chapel called "Svetinja" where, according to tradition, the grave of Venerable Nikolaj Sinajit is located (Спасић 1998: 315-316). Joakim Vujić, when writing about the chapel, mentions the preserved relics of the saint (Вујић 1901: 65), and later Josif Veselić describes in more detail the legend of Nikolaj, the child of a monk who later became a monk himself. According to the legend, the hajduks killed a boy who was then buried by the monks at the place where the hajduks' family would construct a building which, after some time, would be converted into a chapel (Мирковић 2005: 100-101).¹⁹

The folk legend about Nikolaj falls into oblivion, suppressed by a different lore, which is supposed to date from the 19th century, and whose main actor is a Vlach girl, Nikolina. According to one version of the story, Ottoman Turks were responsible for her tragic death and, according to another, more widespread version, hajduks killed her while searching for a monastery to rob. They met the girl while she was tending sheep in a Vlach village and asked her questions that would help them fathom the location of the monastery. Nikolina's answer to each of their questions was "Nu šću nimik" which, translated from the Vlach language, means "I don't know anything", yet the hajduks found the desired place and robbed it. One of the group members, who was also the girl's godfather, expressed concern that she had recognised him, which is why the leader ordered him to kill her. The inhabitants of the Vlach village begin the search for Nikolina, who had not returned home, but they came across her burning body on a tree. The girl was then placed in

an oxcart to transport her body, but the oxen did not want to move until it was suggested to go to the monastery. Nikolina was buried in the place where, after repentance, the girl's godfather built a chapel in memory of her, and the monastery was named Nimnik in remembrance of the words that the girl repeated to the hajduks (Anđelković Grašar and Nikolić 2017: 97).

The retold lore was adapted into a poem "Holy Relic of the Nimnik Monastery", which can be concluded, based on the style and composition, to have been composed in the first decades of the 20th century.²⁰ The original legend of Nikolaj Sinait was replaced by the story of the girl Nikolina, whose potential iconographic inspiration was found in the representation in the profiled triangular field of the marble Roman stele located in the south-western part of the south wall of the monastery. The memory of the girl is preserved by a humanised depiction of Medusa on the tympanum of the ancient spolia (**Figures 4a and 4b**). On the oval face of the mythical creature, which is framed by thick hair with especially prominent curls, the cheeks and sad look are emphasised, and under the chin are stylised snakes that are tied into a Hercules knot (Спасић 1998: 316-317). The fragment of the funerary stele, embedded in the wall of the monastery, dates back to the second half of the 2nd and the first half of the 3rd century AD and originates from one of the Roman sites that administratively and territorially belonged to Viminacium (Николић 2018: 254-255).

The tale was finalised in a song of lyrical sensibility which, although containing metaphors of historical-ideological origin, was based on an older core, myth, or ritual. Lyrical tradition and ancient spolia found the closest analogy in the Rukumija monastery, i.e., to the song "God Settles All Scores", which is much older. Regardless of the chronological differences, both songs hide a mythological meaning and have an identical key motif of the victim, i.e., the innocent suffering of the female protagonist. Sacrifice was necessary in order for a new beginning to be created, and every birth results from death, and death foreshadows a new birth. Christianity incorporated

¹⁹ In the 19th century, the term "hajduk" denoted Balkan brigands or bandits who attacked and robbed the wealthy.

²⁰ All written traces of the poem "Holy Relic of the Nimnik Monastery" have been lost and its original name in Serbian is "Svetinja manastira Nimnika".



Figure 4a. View of the south-western part of the south wall of the Nimnik monastery (photographic documentation of the Institute of Archaeology, Belgrade);



Figure 4b. Tympanum of a Roman funerary stele as spolia, the Nimnik monastery (photographic documentation of the Institute of Archaeology, Belgrade).

concepts such as immortality, universal fertility, and renewal, which permeate the poem and form the essence of fertility myths and mysteries, into the concept of Salvation (Спасић 1998: 318-320).²¹ In the case of the spolia installed in the monasteries of Nimnik and Rukumija, with decoration in the form of a subtle and gentle face of Medusa, whose apotropaic function was accepted, due to folk tale, in the world of Christianity, the triumph of justice, punishment of the guilty and repentance, which was achieved by uniting pagan and Christian ideas, is visible (Milovanović and Andelković Grašar 2017: 177).

CONCLUSION

Medusa's motif with locks of hair curled in the form of snakes, represented alone or in combination with birds, was widespread in almost all Roman provinces, especially during the 1st and 2nd centuries AD. Her image, which adorns the tympanums of ancient funerary stelae, was particularly cherished in the West and was transferred to Pannonia via Italy. As an eagle and a rosette, the Gorgon possessed a symbolic meaning such as prophylactic and apotropaic, and later an astral character on funerary monuments. Medusa's head is represented on numerous Aquincum stelae, dated to the period between Trajan and Antoninus. In Sopiana it appears in the 1st and 2nd centuries AD, on the stela of Brigetius and Intercisa from the first half of the 2nd to the 3rd century AD, and its motif also adorns 2nd and 3rd century AD stelae from Dalmatia, Dacia, and Pannonia. The companions of souls in the afterlife, dolphins, are also combined with the Gorgon motif and can be found on one stele from Singidunum and one from the province of Upper Moesia, more precisely Viminacium, which dates to the middle of the 2nd century AD. According to their skills and abilities, local craftsmen independently made stelae with the widespread and popular Medusa decoration on them (Dautova-Ruševljan 1983: 46-47).

Thanks to its eschatological and protective role, the use of the motif of Gorgon's face continued in Christian visual culture. In Byzantium and the medieval West, the representation of Medusa found numerous applications, and on the walls of

Hagia Sophia, she was a symbol of the triumph of Christianity over paganism, the protector of the Chalke Gate, but also of a private object such as an ink container, whose lid is adorned with Medusa's image that has the function of a guardian of ink, but also the protector of the container from the jealousy of other scribes. The Gorgon also appears in literary texts of the Middle Ages, and its apotropaic function is significantly learned from Ovid's "Metamorphosis" (Milanović and Pilipović 2021: 270-272).

Spoliation, which finds a new use for neglected, damaged, or deliberately removed parts of monuments, is considered a representative phenomenon of medieval culture (Вранешевих и Шпехар 2019: 34), and this is also the case with spolia decorated with representations of Medusa. Spolia built into the texture of a wall of a building were not chosen at random and were not hidden but highlighted together with the complicated, ideological messages they carried. Also, spolia established continuity and connection between the ancient past and the medieval present but also provided magical protection (Kiilerich 2005: 104-106). The motif depicted on the monument took on the role of a talisman, which stemmed from the superstitious Christian view of pagan statues that were not seen as evil but, on the contrary, as powerful (Вранешевих и Шпехар 2019: 35). It is difficult to determine precisely the purpose of the stone spolia used in architecture, but considering that they are mostly visible, it is assumed that this use was of an apotropaic character (Greenhalgh 2011: 86).

Researchers started to look at the process of using spolia contextually, especially on the Balkan Peninsula. The area of Viminacium and the ancient sites in the vicinity abounded in Roman monuments that were chosen as adequate building materials for construction during turbulent times for the medieval Serbian state. The appearance, selection, and new position of the spolia indicate that the builders were guided by the wishes of the founders of the buildings or the creators of the ideas of the Despot's ideological and political programme (Вранешевих и Шпехар 2019: 29-30). In order to emphasise the civil and city concept, as well as his own prestige, Đurađ Branković developed a system of "tying" the Despotate to the continuity of ancient Rome and the political legitima-

²¹ Eleusinian and Orphic Mysteries.

cy of the founder of Constantinople (Цветковић 2011: 400-401). The aforementioned claim suggests that numerous Roman monuments were not built in the fortification walls of Smederevo due to a lack of materials. Unfortunately, the founder of the Church of the Assumption of the Blessed Virgin Mary remains unknown, but it is possible that the inspiration for incorporating spolia into this sacred building was found in the future capital, i.e., the nearby medieval fortress (Milanović and Pilipović 2021: 273). Also, ancient material was used and interpolated during the construction of later churches. After the Second Serbian Uprising and the restoration of Miloš Obrenović, during the 19th and 20th centuries, the local population of the Braničevo district carried away bricks and stones after dismantling the graves (Николић 2018: 39, 243). Based on the assumptions presented, it can be concluded that, under the influence of Antiquity and its authority, the incorporation of spolia was a clearly planned programme of builders and founders with the aim of establishing political legitimacy.

Although they were placed in striking places for better visibility, many people do not know who, how, or why spolia were made. Insufficient knowledge of the real function of the monuments led to their interpretation by the people who explained the unknown by creating a legend that was linked to mysterious and supernatural forces. Considering that folk tales are placed between reality and imagination, they hide certain historical data but, at the same time, they distance the observers from understanding the original function of the monument. In addition to explaining phenomena, folklore formed the basis of what people consider culture, society, and history, and it could also serve to establish cultural heritage, norms, and values, and make a clear distinction between one's own and another's way of life (Voss 1987: 80-81, 88). There is an interesting connection established between the past and the present, but also a bond between the interpretation of folk poems and the ancient Roman spolia built in the medieval Serbian monasteries of Rukumija, Nimnik, and the Church of the Assumption of the Blessed Virgin Mary in Smederevo. Three funerary fragments with the representation of Medusa acquired a different message by incorporating them into the walls of these buildings. The mythical being, with

its powerful gaze, protects the sacred places from unwanted visitors with sinful thoughts, which is best illustrated and concluded with the inscription on the Serapeon's treasury on Delos: "Visitor, do not be afraid to see me, when standing in front of me, Gorgon. Night and day, I am sleeplessly watching the sacrificial room, belonging to God. Throw it joyfully, as much as you wish, through my mouth, into my spacious belly" (Jeremić 2017: 255).

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REZIME

POGLED KOJI MOŽE DA OKAMENI: ANTIČKE SPOLIJE SA MOTIVOM MEDUZE UGRAĐENE U SAKRALNE GRAĐEVINE NA TERITORIJI SRBIJE

KLJUČNE REČI: MEDUZA, GORGONA, MITOLOGIJA, ANTIKA, ZAŠTITA, SREDNJI VEK, SPOLIJE, SAKRALNE GRAĐEVINE, NARODNA TRADICIJA.

Pogled Meduze koji može da okameni predstavljao je opasnost po svakog posmatrača, te je njen lik krasio brojna arhitektonska zdanja, predmete primenjene umetnosti, vojne opreme i nakita rimske epohe. Kao otelotvorenje surove istine da je smrt neizbežan aspekt života, Gorgonina predstava postaje najzastupljeniji dekorativni ornament na funerarnim stelama rimskih provincija.

Predstava Gorgone inspirisana je njenim mitom koji uživa popularnost kod pagana i ranih hrišćana, a njegovi koreni sežu u epohu evropskog neolita i mogu se raspoznati i u indo-evropskoj mitologiji i ikonografiji. Meduzina predstava se vremenom adaptirala, te feminizacijom i ublažavanjem njenih animalističkih karakteristika ona postaje lepa mlada žena. Motiv Meduze postaje jedan od najmoćnijih simbola, a njen izmenjeni prikaz koji krase suptilna, mala krila na glavi i par zmija uvezanih u čvor ispod brade, postaje arhetip „fatalne žene”.

Rimljani su težili da motivima koji simbolišu fenomen umiranja i rađanja kreiraju viziju sveta u kome večno borave duše pokojnika. Takođe, u

rimskoj eposi prisutne su strepnja i briga za sigurnost groba te se, zbog potrebe za zaštitom, na zabatima funerarnih spomenika pojavljuje Meduza sa istaknutom apotropejskom funkcijom.

Kao večni podsetnik na poraz paganske ideologije, pobeckrve i glorifikaciju nove religije, dolazi do upotrebe antičkih spolija sa paganskom konotacijom u hrišćanskom kontekstu. Fenomen spolijacije, koji spomenicima pronalazi novu primenu, predstavljao je zastupljenu pojavu u srednjem veku.

Primer takve spolije uzidan je u gornji deo spoljašnjeg zida Malog grada srednjovekovne Smederevske tvrđave. Na reljefu spomenika prikazana je mitološka priča Povratak Alkeste, dok timpanon spolije krasí zaštitnica ovog spomenika, Meduza, sa dva hipokampa koja je flankiraju. U blizini Smederevske tvrđave nalazi se crkva Uspenja Presvete Bogorodice, u čiji je severni deo zapadnog zida uzidana antička spolija. Gornji deo uzidane funerarne stele dekorisan je predstavom Meduzine glave sa dve ptice smeštene u trougaonu polju spomenika, koja ukazuje na mogućnost da je crkva obnovljena u vreme Miloša Obrenovića, nalik manastirima Rukumiji i Nimniku u čije zidine su takođe ugrađene antičke spolije.

U jugozapadni ugao južnog zida manastira Rukumije uzidana je mermerna spolija na čijem je zabatu predstavljen, frontalno sa pogledom ka posmatraču, Meduzin lik koji sa leve i desne strane flankira po jedna ptica, dok je u trougaonim poljima prikazan po jedan konj sa svojim jahačem. Fragment spomenika predstavlja ikonografsku inspiraciju predanja o braći Pavlu i Radulu i njihovoj sestri Jelici, opevanu u narodnoj pesmi „Bog nikom dužan ne ostaje”.

Narodno predanje i antička spolija Rukumije pronalaze najbližu analogiju u manastiru Nimnik gde je priča o Nikolaju Sinajitu, tačnije o devojčici Nikolini pronašla ikonografsku materijalizaciju na predstavi u profilisanom trougaonom polju mermerne rimske stele, smeštene u jugozapadni deo južnog zida. Sećanje na tragično stradalú devojčicu očuvano je humanizovanim prikazom Meduze na zabatnom delu antičke spolije.

Ljudi su mitove i legende tumačili na mnogo načina, što je dovelo do stvaranja određenih šablona i modela u narodnim pričama koji su služili da pojasne različite pojave. Ista situacija je primetna kod spolija, dekorisanih Meduzinim likom, sa ter-

itorije centralnog Balkana, te se može zaključiti da hrišćanski svet prihvata ovo pagansko mitsko biće zahvaljujući narodnoj tradiciji.

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OVERVIEW OF CONSERVATION AND RESTORATION APPROACHES TO THE PROTECTION AND PRESENTATION OF VIMINACIUM WALL PAINTINGS

ABSTRACT

This paper will present methods of protection and presentation, i.e., conservation-restoration approaches, applied to the remains of wall paintings found within the archaeological site of Viminacium, from the Roman period, that have been applied since 2006. The material was conserved in the conservation and restoration studio on the site itself by conservators and associates of the Institute of Archaeology, while in the previous period it was carried out by the conservators of the Institute for the Protection of Cultural Monuments of Serbia – Belgrade.

The found paintings differed in their degree of preservation, which gave rise to the reasons for the chosen method of conservation and presentation. The presentation of one of the found painted graves and the partially preserved painted composition on one of the walls of the city baths enabled the preservation of examples of painting in its original context, providing visitors with a unique experience. Viminacium is one of the few archaeological sites in Serbia where conservators pay special attention to fragmented wall paintings, and to the restoration of the units that the fragments formerly created. With the help of conservation works carried out on the fragments of the painting, several units were obtained that can allow us to see what the wall decoration looked like in a historical environment. Some of the fragments throughout the presentation remained unrelated to the context from which they originate, so the contribution of hypothetical reconstructions carried out by restorers as well as the use of modern digital technologies is important for their comprehension.

The aim of the work being done by conservators in Viminacium since 2006 is, therefore, that all the remains of the wall paintings of Viminacium are physically preserved and protected, but also that their artistic content, materials and production technology are in some way visible outside the space of the studio, that is presented to other researchers and conservators, as well as the museum audience.

KEYWORDS: ROMAN WALL PAINTING, FRAGMENTS, PRESENTATION, CONSERVATION, RESTORATION, RECONSTRUCTION, VIMINACIUM.

INTRODUCTION

Conservation-restoration treatments of wall paintings are long-term and expensive operations, and without them, most of the archaeological and artistic finds of this type would never be able to be presented to the public. Conservation interven-

tions aim to stop degradation without changing the original shape and appearance of the painting, while during restoration procedures any lost continuity of the painting is restored. Restoration, reconstruction, hypothetical artistic as well as digital, could not be carried out without a lot of previously collected data, which includes photos and

documentation from excavations or previous conservation works, but also work on the scientific interpretation of the images through the discussion of iconography and the search for analogies. Since the 1960s, the conservation profession around the world has strived to preserve wall paintings *in situ*, with the aim of maintaining the integrity of the architectural and archaeological context. Detachment of a wall painting, i.e., removing the painting from the structure of which it was an integral part (Weyer *et al.*: 2015: 344), is considered the last resort, something that is performed only when there is no possibility of its preservation *in situ* (Rainer 2010: 6; Бранди 2007: 187).

Viminacium is one of the archaeological sites found in Serbia with a rich fund of Roman wall paintings (Rogić 2018b: 897–903) (**Figure 1**). Most of the preserved wall paintings originate from funerary structures, since the largest part of the archaeological excavations were conducted in the necropolises. Thus, it has specially preserved wall paintings from graves, and tombs (Pećine site and Pirivoj site) (Anđelković Grašar, Nikolić and Rogić: 2012; Rogić 2018a; Anđelković Grašar, Rogić and Nikolić 2020; Anđelković Grašar, Nikolić and Rogić: 2017; Redžić *et al.* 2018: 85–86, 88–89). The archaeological excavations of Viminacium public buildings were carried out on a smaller scale, but a number of fragmented wall paintings and smaller painting areas from

public buildings, among which are the city baths - *thermae* (Rogić, Despotović and Milovanović 2008; Nikolić, Rogić and Milovanović 2015); amphitheatre (Rogić and Bogdanović: 2012, 46–49; Rogić 2018: 897–899); and small buildings near the amphitheatre (Nikolić *et al.* 2014: 52; Nikolić *et al.* 2017: 65–67) were found. Recent excavations of the legionary fortress also brought to light painting fragments in *principia* (Mrđić, Marjanović and Golubović 2023: 79–80). The excavations of residential buildings, including those from the central urban area of Viminacium, whose modern research has just recently started (Čair site - only small-scale excavations of this part were carried out in 1902 – Vassitz 1904), resulted in the uncovering of many painting fragments (Gavrilović and Milovanović 2021). Finally, the excavations of the private buildings in the suburban settlements and agricultural estates, revealed rare fragments of wall paintings (Nad Klepečkom and Pirivoj sites - Redžić, Danković and Milovanović 2021: 144; Jovičić and Redžić 2014: 58–59; Mrđić and Jovičić 2012: 51).

The exploitation of coal and the production of electricity in the territory that once included the wider area of the Roman Viminacium (**Figure 1**) are considered to be in the national interest so, unfortunately, since 2009, behind the line of protection against the progress of the Drmno strip coal mine, there has been a territory where



Figure 1. The map of Viminacium sites with found wall paintings (Tags: author on Google Earth Pro, photo printed on December 11th 2023 (historical image from March 2023)).

Roman suburban settlements and villas were later explored, while the largest necropolis, the excavations of which was started many decades ago, is under the thermoelectric power plant complex. This necessitated the demolition or relocation of several investigated buildings, graves, and tombs after archaeological excavations, and also the removal of wall paintings that originated from them. Any detachment of wall paintings from the walls of buildings certainly led to the loss of the archaeological and architectural context, but this was the only way for the paintings to remain physically preserved and accessible to future generations (Nikolić, Rogić and Anđelković Grašar 2013: 209–210).

During the construction of the Kostolac B thermal power plant in the village of Drmno, in the 1980s, a large number of graves and tombs were explored on its current site. Among them are a grave marked as G-2624, found in 1983, and grave G-5517, found in 1990, both at the Pećine site (Korać 2007: 33–124, 247–248). The paintings from these graves were detached and conserved by the experts of the Institute for the Protection of Cultural Monuments of Serbia, - Belgrade (Жикић 1984; Станојловић 1991; Станојловић 1994), and then exhibited in the National Museum in Požarevac. During 1987, grave G-5313 was also found at the Pećine site, and its paintings were conserved by experts from the Institute for the Protection of Cultural Monuments of Serbia – Belgrade, after their detachment (Станојловић 1988). The wall paintings detached from the grave marked G-5464 found at the Pećine site in 1988 and conserved by experts from the same Institute (Korać 2007: 18–22, 258–259; Станојловић 1990), are exhibited in the Viminacium Museum at the archaeological site itself.

Since 2006, the conservation of wall paintings has been carried out in a conservation and restoration studio at the archaeological site of Viminacium. This paper will give a brief overview of the conservation-restoration approaches carried out so far in this studio and on the buildings themselves for the purpose of their protection and presentation, seen in many examples, as well as an example of one of the graves with preserved *in situ* wall painting, which is part of the Viminacium Archaeological Park, and whose conservation was carried out previously by the experts

of the Institute for the Protection of Cultural Monuments of Serbia – Belgrade. In addition to the examples shown, during the last seventeen years, the conservation of numerous fragments of paintings found during Viminacium excavations was accomplished in the studio, but their presentation has not yet been completed.

APPLIED CONSERVATION AND RESTORATION APPROACHES

In the studio for the conservation of wall paintings at the archaeological site of Viminacium (**Figure 2**), different methods are applied. Fragmented wall paintings, are given special attention during conservation in Viminacium, and their hypothetical reconstructions with the aim of their comprehension are executed to allow scientific interpretation of the iconography and presentation.

Today, during archaeological excavations, very fragmented wall paintings are often found in the ground, which are most often collected by archaeologists. In such cases, the most important thing for a conservator is to have good photographic documentation compiled during the archaeological excavations. However, it is always more desirable for conservators to extract wall painting fragments from the ground during archaeological excavations, which has mostly been the case at the Viminacium sites, including the amphitheatre (Rogić and Bogdanović 2012: 47–48), from which a large number of wall paintings originate, both from the arched wall of the amphitheatre, and from the structures within the building, which have undergone conservation and restoration processes in the conservation-restoration studio within the archaeological site.¹

¹ The conservation of wall paintings originating from several structures of the amphitheatre was carried out during the period from 2013 to 2015 and in 2017 as part of the projects *Conservation and presentation of wall paintings from the archaeological sites of the Amfiteatar (Amphitheatre)*, *Objekat sa apsidom (Building with an Apse)* and *Skladište mazuta (Mazut Storage) - Viminacium* and *Conservation and presentation of wall paintings from the archaeological site of the Amfiteatar (Viminacium)*. Conservation of the so-called *memoria* explored in 2016 within the Kostolac B thermal power plant, as well as the wall paintings of grave G-3130, were carried out in 2017 as part of the project *Conservation and presentation of wall paintings from the archaeological sites of the Amfiteatar*



Figure 2. Studio for conservation and restoration in Viminacium (photo by the author).

The units of wall paintings that were within the buildings in the endangered zones of the Drmno strip coal mine or the Kostolac B thermal power plant had to be detached from the masonry structures, which then underwent dismantling or relocation. This process was carried out in two ways, both known in conservation: the *stacco a massello* technique, which involves the removal of the paint layer with the plaster (rendering) layers (*intonaco* and *arricio*), but also with a part of the wall support; and the *stacco* technique, whereby the paint layer is detached only with the plaster (rendering) layers (Mora, Mora and Philipot 1984: 247; Dragutinović Komatina: 2004: 9; Weyer *et al.* 2015: 344–345). As far as new supports are concerned, polyester supports were made for all paintings conserved before 2013. Since then, they have been used occasionally, in the cases of curved or polygonal walls, while the aluminium honeycomb panels (sandwich panels) are used generally as new supports. Aluminium honeycomb panels are characterised by their high durability, lightweight material, and the possibility of later separation of the painting where need-

ed. These supports were used for the conservation of wall paintings in Serbia for the first time in the Viminacium studio. Before that, in Serbia, they were used in the conservation of mosaics².

When considering the materials to be used for conservation and restoration of wall paintings in Viminacium, those compatible with the characteristics of the materials of the original paintings have been always used. Since 2006, nanolime has been used to consolidate the plaster, while previously it was lime-casein acrylic binder that was used for these purposes. As for the consolidation of paint layers, the Paraloid B72 solution was the choice in all conservation treatments in Viminacium. Acrylic resins are used for the purpose of conservation of the fragments and their subsequent joining together into units. Conservation and joining of fragments were not carried out at all prior to 2008.

Conservation extends the lifespan of a work of art, while restoration reveals and complements its aesthetic value, integrates new parts into existing ones, but with respect for the authenticity of the original painting. As for restoration, the *tratteggio* retouching technique is applied in the Viminacium

(*Amphitheatre*), *Objekat sa apsidom (Building with an Apse)* and *Skladište mazuta (Mazut Storage)* - Viminacium. All projects were financed by the Ministry of Culture and Information of the Republic of Serbia. The principal investigator was dr Dragana Gavrilović.

² Dr Maja Franković, conservator from the National Museum in Serbia, introduced the use of aluminium honeycomb panels in the conservation of mosaics in Serbia (Франковић 2010: 218–220).

studio, which unequivocally separates the original painting from the restored one, together with standard retouch (reintegration), which has a weaker colour intensity compared to the original painting.

Leaving a wall painting in its original physical context does not always mean that it will have optimal conditions for preservation, because if it is exposed to direct atmospheric influences, its deterioration is inevitable (Rizzi 2007: xxii). The climate in Viminacium is drastic, the summers have markedly high temperatures, with strong gusting winds that bring abrasive sand from the strip coal mine and alternating stormy and rainy days being quite usual, while the winters are very cold, with a lot of precipitation and frosty periods. Thus, the presentation of any wall painting *in situ* in these conditions certainly requires the protection of the space in which it is located. Today, in Viminacium, preserved *in situ* paintings can be found within the city baths – *thermae*, and in a grave of the necropolis at the Pirivoj site, i.e., in sheltered areas, covered with protective structures (Nikolić 2018).

Within the Viminacium Archaeological Park, the wall paintings are presented *in situ*, but also in the form of museum exhibits, after the transfer of the entire painting units or the collection of fragments found in the ground, which were later joined into units. Various conservation and restoration techniques have been applied to these paintings, depending on the conditions of their future exposure and their state of preservation. The creation of painted or digital hypothetical reconstructions is an indivisible part of the scientific interpretation of wall paintings in Viminacium, not only regarding damaged painted surfaces, but also when only a few small painting fragments have survived.

WALL PAINTINGS PRESENTED *IN SITU*

Wall paintings in public buildings

City baths - *thermae*. The *thermae* of Viminacium are covered with a protective structure and have been archaeologically investigated on several occasions, since the 1970s (Nikolić, Milovanović and Raičković Savić 2017: 3-4). In the south-eastern part of the thermal baths, on

the outer wall of the so-called room 4, in 2004, a preserved wall painting *in situ* was discovered (Gavrilović and Milovanović 2021: 22; Рогич 2014a: 162–163) (**Figure 3**). Archaeological finds confirm that room 4 was used during the 3rd and 4th centuries (Миловановић 2008: 53).

Two layers of wall painting were found, one over the other. The painting from the earlier phase contains an imitation of marble panelling, while the painting from the later phase has a floral decoration, as well as border strips (Gavrilović and Milovanović 2021: 22; Рогич 2014a: 162–163). During the conservation of this painting in 2008, only the edging repair was done, which is a common conservation procedure, when the weakened edges of the wall painting are strengthened with plaster. The paint layer was stable and there was no need for any other interventions. The entire process of conservation was carried out by experts from the Institute of Archaeology.

Wall paintings in a funerary context

Tomb with Cupids. The Tomb with Cupids (G-160) is dated to the very beginning of the 4th century (Korać 2007: 125–140; Anđelković Grašar, Nikolić and Rogić 2013: 73–100; Рогич 2014a: 210–222). The painting was preserved and presented *in situ*, at the Pirivoj site (where it was found during archaeological excavations in 2003), within the visitor space under the protective structure (**Figure 4**).

This is the first painted grave at Viminacium where conservation of painting was carried out *in situ*. In the period from 2003 to 2005, conservation was carried out by the Institute for the Protection of Cultural Monuments of Serbia. The wall paintings were cleaned, consolidated, filled, and restored (Станојловић 2008: 147–148). Given that the floor was removed from the grave, that a corridor was built through the ground to the area in front of the grave, today visitors can enter the grave space from the level below the floor and view the painting, which is probably the first example of such an exhibition of funerary wall paintings in our region (Anđelković 2012: 1–6; Anđelković Grašar, Nikolić, Rogić 2013: 74); Станојловић 2006: 144; Станојловић 2008: 145–146).



Figure 3. City baths – thermae, room 4, wall painting *in situ* (photographic documentation of the Institute of Archaeology).



Figure 4. Grave G-160, wall painting *in situ* (photographic documentation of the Institute of Archaeology).

WALL PAINTINGS AS MUSEUM EXHIBITS

Wall paintings from public buildings

Amphitheatre, Construction 1. Within the so-called Construction 1, found north of the eastern entrance to the arena, which represents a small built structure of supposed cult purpose, fragments of wall paintings were found in 2008. The construction is dated to the first half of the 2nd century (Bogdanović 2019: 88, 90, 397, fig. 97). The uniqueness of its painted representation is reflected in the specificity of the artistic content, as well as the existence of the painting from an earlier phase below it (Рогіћ 2014a: 131–138; Rogić 2014b: 507–512; Rogić 2017: 154). First, the floral decoration was noticed, and then, after detaching the painting with the plaster layers, a wall painting from an earlier period appeared ((Рогіћ 2014a: 132). The surface of this painting was deliberately damaged in the past (keying by

hammering) in order to better set the plaster layer for the painting from the later phase.

Fragments from the later phase were joined back together (**Figure 5a**) and the resulting unit was transferred to a new support. A completely reversible conservation procedure was then carried out. The original plaster was not levelled, but with the help of 3D scanning, a composite support was created that follows all the unevenness of the original plaster (Rogić 2017: 153–154) (**Figure 5b**). The basic idea was to preserve the back of this plaster, and for this reason, glue was applied only to those parts where there was no original plaster.

Fragments of painting from the earlier phase were joined together, then, after consolidation, the back of the plaster was thinned, and then a reinforced polyester support was made (**Figure 5c**). It was decided to use a polyester support because of the curved side of the wall painting unit. In order to consider the iconographic presentation, a hypothetical painted reconstruction of the painting from the later phase was done (Rogić 2018: 899,



Figure 5a. Construction 1 - Merging fragments of the wall painting from the later phase (photo by the author).

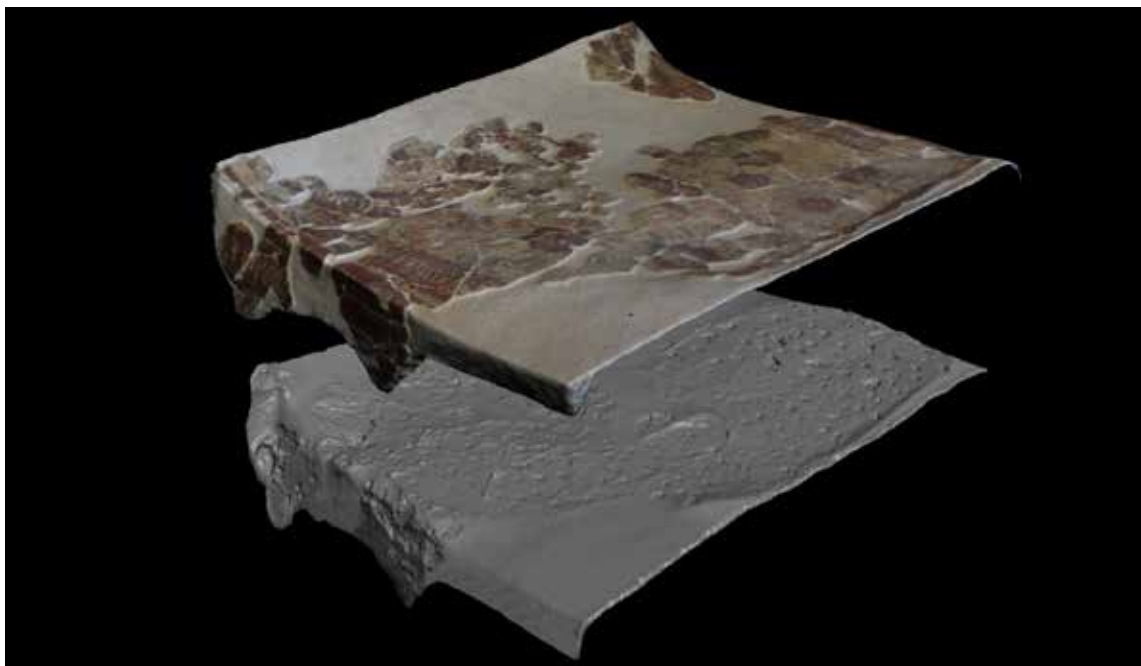


Figure 5b. Construction 1 - Wall paintings from the later phase were put on a composite support that was created to follow all the unevenness of the original plaster (model by Ž. Jovanović).



Figure 5c. Construction 1 - Conservation of wall painting from the earlier phase (photo by the author).

fig 2). The conservation and restoration of this wall painting was carried out by the experts of the Institute of Archaeology from 2013 to 2015, after which the painting was exhibited in the Viminacium Museum in the Viminacium Archaeological Park.

The entire process of conservation, restoration and reconstruction of the context of this painting was carried out by conservators from the Institute of Archaeology with the help of experts from the Centre for New Technology Viminacium

Amphitheatre, Construction 2. A small collapsed masonry structure called Construction 2, of presumed cultic purpose, was discovered and investigated in 2010 under the auditorium of the amphitheatre. It dates back to the first half of the 2nd century (Bogdanović 2019: 88, 90, 397, fig. 97). Fragments of a wall painting were found within it, while only a small part of the painting remained preserved *in situ*. After detaching all the fragments from the structure and collecting others from the ground, they were all transferred to the conservation studio.

During conservation and restoration in the period from 2013 to 2015, the fragments were joined

together to the extent that the available material allowed (**Figure 6a**), so that one large unit was obtained, as well as a number of smaller ones (Poriš 2014a: 139–149). Due to the very uneven thickness of the plaster, it was decided to level the backs of the joined units with the use of a grinder. Based on numerous analogies, we came up with the possible appearance of the interior of the structure. The photogrammetric method was used to measure all the curvatures of the joined units (**Figure 6b**), on the basis of which a model of the interior of the structure was created. A real-size reconstruction of the structure was made of polyester resin and fibreglass (Rogić 2017: 154–156) (**Figure 6c**).

The biggest problem was the curvature of the surfaces of the conserved units, because each unit had to be glued together separately. After that, a decorative plaster was applied and, finally, a *tratteggio* retouching technique was used, which visually mutually connected the installed units. In order to gain a better comprehension of the iconography, a painted reconstruction of the painting was done as well (Rogić 2018: 899, fig 2).

The entire process of conservation, restoration



Figure 6a. Construction 2 - Merging fragments of the wall painting (photo by the author).



Figure 6b. Construction 2 - Photogrammetry process (photo by the author).

and reconstruction of the partial context of this painting was carried out by conservators from the Institute of Archaeology with the help of experts

from the Centre for New Technology Viminacium.

Amphitheatre, wall of the arena. During archaeological excavations in 2009, it was found that in the soil next to the arena wall (south-western part of the arena) there were layers of irregularly distributed wall painting fragments that had fallen from the once painted arena wall (**Figure 7a**). The painting is dated to the first quarter of the 2nd century (Rogić and Bogdanović: 2012).

The largest part of the work was the extraction of these fragments from the ground, which was done by conservators from the Institute of Archaeology, after which they worked on the classification of materials by colour and type of rendering, consolidation of the fragments and joining them together into units as much as the available material allowed (**Figure 7b**).

Due to the very uneven thickness of the type of



Figure 6c. Construction 2 - Reconstruction of Construction 2 with the fragments of the original wall painting (photo by the author).



Figure 7a. Amphitheatre arena wall - Drawing the layout of the fragments *in situ* near the arena wall (photo by the author).



Figure 7b. Amphitheatre arena wall - Joined fragments of one of the painting units from the arena wall (photo by the author).

rendering, which at the same time had no special visual characteristics, it was decided to level the back of the joined units with the use of a grinder. The units obtained (nine units have so far been made, and a separate publication about them is being prepared) were transferred onto aluminium honeycomb panels. Edging repairs, decorative rendering and retouching were carried out and the *tratteggio* retouching technique was applied, with conservation lasting from 2013 to 2015 (Рогић 2014a: 148–154; Rogić 2017: 153, 156–157). Additionally, part of the hypothetical painted reconstruction of the arena wall painting was completed (Рогић 2014a:153; Bogdanović, Rogić and Vuković-Bogdanović 2018: 46) (**Figure 7c**).

Wall paintings from funerary context

Grave G-3130. The grave marked G-3130 was found during archaeological research in 1983 at the Pećine site (location Skladište mazuta). It is dated to the second half of the 4th century. This grave was vaulted, and the painted vault had a lavish iconographic representation. In the remains of the painting on the longitudinal sides (western and eastern), one can see exactly the same iconographic scheme that is, an imitation of stone panels, while on the front sides, parts of peacock legs can be seen (Копан 2007: 23–24; Рогић 2014a:

223–226; Rogić 2018a) (**Figures 8a and 8b**).

After the detachment of paintings from the structure, in the period from 1983 to 2009, the western longitudinal and southern front sides were conserved by experts from the Institute for the Protection of Cultural Monuments of Serbia - Belgrade (Станојловић 1990). The northern and eastern sides were conserved in 2017 in the Viminacium studio by conservators and associates of the Institute of Archaeology (**Figure 8c**).

Conservation works in 2017 were started by removing the bricks from the back of the wall paintings, with which they were transferred in 1983. After consolidation and levelling of the plaster, i.e., its thinning, a reinforced polyester support was made and applied to the already conserved units. Also, a similar decorative plaster was chosen, whose grey, neutral colour highlighted the painted content. A standard retouch was performed.

Although the wall paintings of this grave were conserved and restored, and exhibited in the Viminacium Museum (**Figure 8a**), without the proposed hypothetical reconstruction of the painting carried out as part of the conservation process (**Figure 8b**), the iconographic representation could not easily be comprehended. For this reason, these reconstructions of the painting are extremely significant, but only when it comes to



Figure 7c. Amphitheatre arena wall - Painted hypothetical reconstruction of the part of the painted decoration from the arena wall, made on the basis of the original painting (after: Рогић 2014a: 153, fig. 11; and Bogdanović, Rogić and Vuković-Bogdanović 2018: 46, fig. 3).



Figure 8a. Grave G-3130 - Removal of old facing (photographic documentation of the Institute of Archaeology).



Figure 8b. Grave G-3130 - Eastern longitudinal and southern front side of the grave after conservation (after: Rogić 2018a: 173, fig. 6, 180, fig. 15).

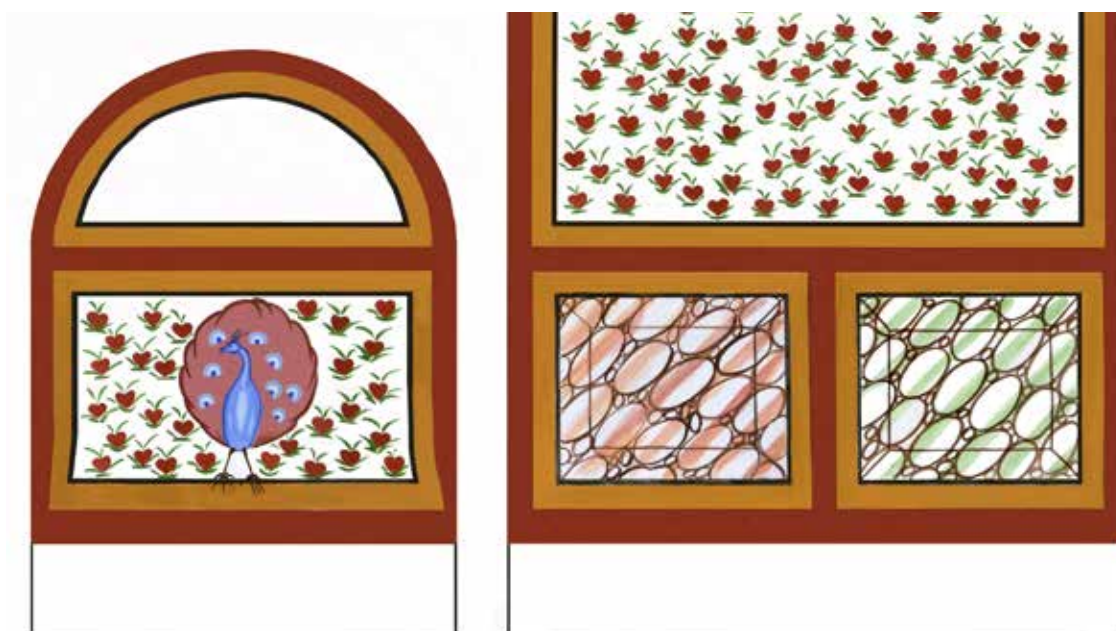


Figure 8c. Grave G-3130 - Painted hypothetical reconstruction of the painting (after: Rogić 2018a: fig 23, 188).

artistic elements whose existence can be assumed with a high degree of certainty.

Memoria. During the archaeological excavations for the construction of a new industrial facility within the thermal power plant Kostolac B in the village of Drmno, carried out in 2016, a tomb was found, the so-called *memoria*, with the remains of a wall painting *in situ* (**Figures 9a and 9b**), dated to the middle of the 4th century (Redžić *et al.* 2018: 85–86; Vojvoda, Redžić 2020: 225). On the remains of wall paintings, imitation of stone panels can be recognised (**Figure 9c**).

Unfortunately, the tomb had to be relocated, given its position. This meant detaching the paintings from the walls beforehand. First, the wall paintings were cleaned (**Figure 9b**) in order to determine their state of preservation and then they were protected with facings. The paintings were protected with rigid supports - solid wooden structures, after which they were removed. The wall was cut from the back, the bricks were gradually separated to the plaster of the wall painting, and the paintings were transferred to the conservation studio. Then, work was carried out on the stabilisation of the plaster, so the creation of polyester

supports was initiated. Edging repair was done and, after drying, decorative plaster was applied, the lacunas were filled, and retouching was carried out (Redžić *et al.* 2018: 86). The conservation process was carried out in 2017. After the conservation, the wall paintings were displayed on the walls of the Viminacium Museum (**Figure 9c**).

Conservation works were done by the experts of the Institute of Archaeology.

HYPOTHETICAL RECONSTRUCTIONS OF WALL PAINTINGS

In the previous text some painted hypothetical reconstructions of paintings found in fragments but later joined into units, were shown. There are cases when the discovered fragments would not allow us to physically form larger painted units by joining them together. However, they can be *joined* in a wider picture by making various hypothetical reconstructions as well.

Nad Klepečkom site. During the period from 2008 to 2009, protective excavations were carried out at the Nad Klepečkom site, in probe no.19.



Figure 9a. *Memoria* - Wall painting in the corner of the central room (photo by the author).



Figure 9b. *Memoria* - Cleaning of the painting layer *in situ* (photographic documentation of the Institute of Archaeology).



Figure 9c. *Memoria* - Conserved and restored wall paintings (photo by the author).



Figure 10. Hypothetical reconstruction of the painting scheme from the structure of the Nad Klepečkom site (after: Рогоћ и Марковић 2010: 181, fig. 4).

Fragments of wall painting were found in a hole that primarily served as a lime-slaking pit, which, in its secondary use, became a waste pit. According to archaeological finds, it can be dated to the 2nd or 3rd century. Whether the paintings decorated the walls of the tomb or a building of an unknown purpose, cannot be determined with any certainty (Рогоћ 2014: 184–189).

Based on the measurements that were taken from the fragments, the hypothetical reconstruction was made using computer programmes and photos of the original fragments (**Figure 10**). A more detailed analysis of all the fragments led to the idea that the yellow and green rectangular fields were joined by diagonals starting from the corners of the rectangular fields. The diagonals and fields together create irregular hexagonal areas that contain a floral motif in their centre, with petals that are mostly heart-shaped. By drawing the conceptual solution, and de-composing this scheme, it was concluded that there were two octagon schemes to be considered. The intertwining colours of these schemes on the white background are yellow and green, with the yellow coming to the fore, giving the impression of depth (Рогоћ и Марковић 2010).

DISCUSSION

The conservation approaches in Viminacium before the 2000s included the work of conservation experts on the detachment of the wall paintings found in the graves and tombs during a large archaeological campaign of protective excavations in the area under the present Kostolac B thermal power plant complex, in the pe-

riod from 1977 to 1997 (Zotović 1986, 41–60; Zotović, Jordović 1990; Korać, Golubović 2009; Golubović, Milovanović, Redžić 2022), and their later conservation and presentation to the public as museum exhibits. These were exceptionally well-preserved wall paintings found in the graves excavated among more than 13,500 of them during the campaign (Korać, Golubović 2009, 12). The protective nature of the excavations did not allow for the preservation of the paintings *in situ*, so these paintings needed to be detached from the walls.

The only Viminacium funerary paintings preserved and presented *in situ* are those from the grave named Tomb with Cupids. Its preservation *in situ* was only made possible by having appropriate conditions in which to do so. In 2002, the formation of the Viminacium Archaeological Park began, when the newly established conditions for the preservation and presentation of excavated structures were introduced, using modern wooden constructions as shelters above the excavated structures. Soon after, the erection of a modern building for the researchers and visitors was started, offering a space for the Viminacium on-site museum that included an area for the exhibition of the wall paintings (Николић 2014). Finally, the conservation studio was built at the site of Viminacium, to complement the excavations and multidisciplinary research that have been carried out constantly at this site since 2002 (Korać 2019). These modern excavations brought to light a large (~2,500), but still smaller compared to the previous excavation campaign, number of graves (Vojvoda, Anđelković Grašar 2022: 13; Redžić,

Golubović, Vojvoda 2022) with partially preserved wall paintings.

Although no paintings that, in terms of preservation and richness of iconographic content, can be compared with those found during the large excavations of the necropolis in the last century have been found since then, modern excavations have yielded numerous buildings (Korać 2019) of public or private purpose whose walls were painted. These mostly fragmentarily found paintings are carefully collected and later joined together into units in the conservation studio. Restoration, as the greatest challenge for conservators, became a frequent activity, since large parts of the painting compositions were often missing. The Viminacium conservators are also scientific researchers, dealing equally with material analysis, iconography studies, and practical conservation work. This has brought a new perspective on the need for research and preservation of found fragments in Viminacium, irrespective of their condition or size.

The development of technology brought modern methods for the recording and visualisation of artifacts into archaeology, which greatly helps in the interpretation and virtual reconstruction of numerous painting fragments in Viminacium. One example was a fragmented composition, previously described as Construction 1 from the amphitheatre, where additional effort was made to present all the original plaster layers. A digital model of the once-painted structure was of immense help in this process, allowing a real physical structure as a support for the fragments to be made. Regarding the conservation activities carried out on the paintings from Construction 2, also excavated in the area of the amphitheatre, the physical reconstruction of a structure done with the help of digital technologies and its use as a new support for the original painting fragments had never been carried out in Serbia before. This type of physical reconstruction satisfies the elementary principle of presenting the integrity of the structure, for which former Viminacium conservators advocated through their texts on the presentation of paintings detached from Viminacium graves (Станојловић 1997). However, it has been realised only with the conservation and presentation of Construction 2 from the amphitheatre at this archaeological site in 2015.

The constant presence of conservators, who are responsible only for this site, at Viminacium since 2006, a site where archaeological excavations continue throughout the year, has also influenced the improved attitude of all Viminacium researchers towards the remains of wall paintings and their careful collection during archaeological excavations, as well as the efficiency of conservation that has since been taking place simultaneously with excavations. The existing positive conditions for carrying out continual conservation on the site means that the paintings no longer have to wait for the interventions for a long period of time after they are excavated and initially treated, as was often the case in the earlier period. Additionally, they allow the collected fragments to be stored and later joined together into units, which can later become museum exhibits as well, which was not possible in the previous period.

CONCLUSION

In Viminacium, archaeological excavations have so far been carried out mostly in the context of the necropolis, so Viminacium paintings found almost in their entirety and preserved *in situ*, originate from burial structures, while small painting units found *in situ* and fragments buried in the soil next to collapsed structures, are mostly associated with secular structures. The excavations of Viminacium, apart from the necropolis, included mostly locations outside the city zone, as well as suburban settlements, so numerous private houses, and estates were found, which belonged to owners of different property status, according to which the walls were decorated. Unfortunately, these remote locations were exposed to greater destruction in the past, as were the paintings found in them. The city centre and the legionary fortress were explored to a much lesser extent, but, in contrast to the periphery, these excavations yielded more significant results related to the extent of preservation of wall painting, as evidenced by the wall paintings of the city baths and amphitheatre, preserved in smaller *in situ* units or the large number of fragments that were later, however, integrated into units, following a further conservation process.

During seventeen years of conservation work in Viminacium, each project has been different,

depending on the state of preservation of the wall painting and the conditions in which it was found. The work on the conservation includes the participation of conservators in two contexts - work in the field and work in the studio. Regarding the work in the field, the activities differ depending on the level of preservation of the paintings themselves. Apart from the wall paintings that were preserved and presented *in situ* within the city baths and the necropolis at the Pirivoj site, both covered by protective structures, some wall paintings had to be detached from the walls in order to be conserved, while many were found in fragments already separated from the structures to which they once belonged. Here, wall painting conservators and archaeologists generally work in sync, which contributes to conservation and restoration activities being better organised, and more efficient. In the studio for the conservation of wall paintings in Viminacium, various methods and techniques of conservation and restoration are applied in order to preserve paintings and then present them to the public. When fragments are conserved and put together into a unit, and missing elements are added through the restoration process, they form portable exhibits that are displayed in the museum space. When there is no reliable data for the complete physical restoration of the wall painting, hypothetical reconstruction is carried out.

Viminacium is an extremely important and rich archaeological site, considering the amount of data it has provided to researchers, based on which conclusions can be drawn regarding all aspects of life in a city territory in a province of the Roman Empire. It is also one of the few archaeological sites in Serbia where conservators pay special attention to fragmented wall paintings, and to the restoration of the units that the fragments formerly created. Future excavations inside the city and the fortress will surely yield discoveries of many wall painting remains. Based on their research, we will be able to make many precious conclusions about their different characteristics: the materials used, and the applied technology and presented iconography, which was often dependant on the status of the building owner, the building's function, its complexity, or its importance.

The aim of the work, carried out since 2006, of conservators in the studio at Viminacium has been and continues to be to ensure all the remains of

the wall paintings of Viminacium are physically preserved and protected, but also that their artistic content, materials and production technology are in some way visible outside the space of the studio, scientifically interpreted and presented to other researchers and conservators, as well as to the museum audience.

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REZIME

PRIKAZ KONZERVATORSKO-RESTAURATORSKIH POSTUPAKA U ZAŠTITI I PREZENTACIJI ZIDNOG SLIKARSTVA VIMINACIJUMA

KLJUČNE REČI: RIMSKO ZIDNO SLIKARSTVO, FRAGMENTI, PREZENTACIJA, KONZERVACIJA, RESTAURACIJA, REKONSTRUKCIJA, VIMINACIUM.

U ovom radu su prikazani načini zaštite i prezentacije, odnosno konzervatorsko-restauratorski pristupi primenjeni na ostacima zidnog slikarstva pronađenog u okviru arheološkog nalazišta Viminacijum iz rimskog perioda, a koji su danas izloženi *in situ* ili kao muzejski eksponati u istoimenom arheološkom parku. Ovaj materijal je do sada bio konzerviran od strane konzervatora i saradnika Arheološkog instituta, kao i konzervatora Republičkog zavoda za zaštitu spomenika kulture.

U ateljeu za konzervaciju zidnih slika na arheološkom nalazištu Viminacijum od 2006. godine primenjuju se različite metode i tehnike konzervacije i restauracije zidnog slikarstva. Tokom dugogodišnjeg rada svaki konzervatorsko-restauratorski projekat je bio različit. Razlozi za odabranu metodu konzervacije i prezentacije su zavisili od stanja i stepena očuvanosti zidnog slikarstva, kao i uslova u kojima je ono pronađeno tokom arheoloških iskopavanja. Viminacijum je jedno od retkih arheoloških nalazišta u Srbiji čijem se fragmentisanom zidnom slikarstvu posvećuje posebna pažnja u vidu konzervacije i restauracije, ali i hipotetičke rekonstrukcije, u cilju koja se vrši u cilju njegove naučne interpretacije.

U okviru arheološkog parka Viminacium, *in situ* su konzervirane delimično očuvana slikana kompozicija na jednom od zidova gradskog kupatila, kao i zidno slikarstvo grobnice G-160, pružajući mogućnost za jedan od posebnih vidova prezentacije. Do samog groba dolazi se podzemnim hodnikom, a iz groba je uklonjen pod kako bi posetilac ušao u grobni prostor i razgledao slikarstvo. Veće celine zidnih slika koje su bile u okviru objekata u ugroženim zonama površinskog kopa uglja Drmno i termolektrane Kostolac B, morale su biti odvojene od zidanih struktura kojima je sledilo razgrađivanje ili izmeštanje. Ovaj proces je vršen na dva načina, oba poznata u konzervaciji, odnosno tehnikom *stacco a massello* koja predstavlja odvajanje zidne slike sa malternim slojevima i zidnim nosiocem; i *stacco* kada se vrši odvajanje zidne slike samo sa malternim slojevima. Od 2013. godine kao novi nosači upotrebljavani su paneli od aluminijumskog saća, ali se nastavilo i sa upotrebom poliesterskih nosača ukoliko

su postojala zakrivljenja zidova. Što se tiče restauracije, u viminacijumskom ateljeu se primenjuje *trattegio* restauracija, kojom se nedvosmisleno odvaja originalno slikarstvo od restauriranog, ali i standardni retuš koji ima slabiji intenzitet boje u odnosu na originalno slikarstvo.


Cilj rada konzervatora u Viminacijumu koji se obavlja od 2006. godine je, dakle, da svi ostaci zidnog slikarstva Viminacijuma budu fizički sačuvani i zaštićeni, ali i da njihova umetnička vrednost, upotrebljeni materijali i tehnologija izrade budu na neki način vidljivi i svima van prostora konzervatorskog ateljea, odnosno da se prikažu istraživačima, konzervatorima i muzejskoj publici.

* * *

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THE CHALLENGE OF A SUCCESSFUL MORTAR INTERVENTION IN HISTORICAL BUILDINGS

ABSTRACT

Modern societies can understand the value of preserving their cultural heritage in order to safeguard their history but also to ensure the future of generations to come. Nowadays, scientists and conservators can exploit the accumulated experience from many case studies performed to learn from the past and improve this knowledge. New challenges can be incorporated into the consideration of successful intervention in historical structures, such as sustainability issues and circular economy. The methodology applied to the analysis and application of compatible mortars should be based on scientific criteria, while norms and nomographs should be formed to ensure the precision of the works. Cooperation between different disciplines remains the key factor in the success of these efforts.

KEYWORDS: HISTORIC STRUCTURES, MORTARS, SUSTAINABILITY, COMPATIBILITY, METHODOLOGY.

INTRODUCTION

Historical buildings comprise a great number of different structures, which include many values, and their protection is essential for our civilization. They are structures listed individually in the national registers of historical monuments, sites or places and manifests of significant value (i.e., historical, artistic, cultural, social or economic). These structures can inspire and teach new generations while they connect the past and the future of humanity. They constitute a countless number of different types of constructions dated from prehistory to present, making them a real treasury of human civilization. According to Burman (Burman 2001), their survival is essential to the spiritual, emotional and economic well-being of humans. Preservation of such buildings is a global challenge as these remaining structures highlight our past (culture, religion, civilization) but they also teach morals for the generations to come. Today, in modern societies they are artistic,

cultural as well as economic poles. During their lifespan, many of them require maintenance as the materials age, but they also suffer the effects of different events such as earthquakes, floods or even fires. The problem has grown bigger during the last decades, with climatic changes becoming more severe.

Old structures built under different social and technological status should be protected so that they can be adapted to new requirements. The principles under which any interventions should be done in these buildings are described in Charters and Declarations (Venice Charter in 1964 - ICOMOS 1964; Nara Document on Authenticity in 1994 - ICOMOS 1994), which recommend the use of compatible to the authentic materials. The increasing awareness of society about safeguarding heritage buildings and at the same time protecting the environment promotes strategies of combining principles of restoration with environmentally friendly materials and techniques.

Society's awareness about heritage structure

preservation has increased globally because of the higher recognition of the “values” associated with social changes and the economic value of cultural tourism. The value of a monumental structure or area is increased after its preservation. Therefore, strategic policies of preserving built heritage have been promoted, including the development of seismic strengthening measures, and the establishment of regulatory frameworks and management systems. Technological advances in this field have fuelled the market with many innovative materials and techniques or even new concepts of confronting seismic risk. The preservation of these structures concerns both life expectancy and protection from collapse as a result of earthquakes in seismic regions, or from other natural or anthropogenic disasters (Lourenço 2006). The former is closely related to the conservation/consolidation from decay phenomena due to the ageing effects of the environmental impact on buildings. Collapses are most often attributed to the inherent inadequacy of historical masonry structural systems when required to bear horizontal loads.

The great diversity in the typology of the masonry of historical structures due to the various components, techniques of construction, morphology, type of reinforcement and functionality makes their study, in terms of time and cost, challenging. The approach to preserving a structure of high value needs to follow guidelines defined by the Charts and regulations and should aim to retain the authentic parts of the structures. These structures need appropriate high-quality interventions to ensure satisfactory long-term performance and aesthetic continuity. The demanding sustainability is mainly driven by environmental and economic reasons. In parallel, many of these structures can change their use and continue to serve in a society with an active role.

CONSERVATION UNDER THE PRISM OF SUSTAINABILITY

Historical structures were usually load bearing masonries made of brick, stone, wood and mortar. These materials were usually locally sourced and were combined in a variety of different ways. These buildings have proved their sustainability as a result of the principles used for their construction and their long-lasting performance.



Figure 1. Historical structure of Hagia Sophia (Greece), Thessaloniki, 6th century AD (photo by the author).

During the second half of the 20th century, a lot of research was performed in order to propose solutions for the restoration and rehabilitation of historical structures.

Figure 1 shows some typical Byzantine masonry with thick mortar joints (the thickness of the joints is almost equal to that of the bricks). The pathology of this masonry is restricted to small cracks (in the joints but also in the bricks) while loss of material can be seen at the edges of the mortar. The dawn of the 21st century brought an acute climatic problem. In light of this, research into compatible restoration mortars incorporated new ideas based on recycling principles and circular economy. One of the problems arising is that of the repair materials that have to fulfil the criterion of compatibility with those already existing in the structure, the old building materials. Many studies have been made concerning the parameters that can be tested to produce strong, durable and compatible new repair materials.

Figure 2 shows an example of a worksite at a Roman site in Dion. The application of compatible mortars based on lime and natural pozzolan



Figure 2. Restored masonry of a Roman site (Dion- Greece) (photos by the author).

(Figure 2 - top) as well as lime-based grouts to strengthen the masonry (Figure 2 - bottom) is indicated.

To understand the behaviour of the structure it is essential to find the role of the materials used, such as the mortars, or to characterise their type according to their use. It is also required to investigate the mechanisms of the decay and determine the grade of deterioration. The possibility of producing repair mortars incorporating secondary materials was tested by different scholars in previous years. The alternative material tested was recycled fine aggregate originating from mixed construction and demolition waste, bio-fibres, artificial pozzolans, plastics etc. (Stefanidou *et al.* 2014; Stefanidou *et al.* 2021; Safi *et al.* 2013). The results, despite restrictions, have had a positive outcome in most cases. In this way, a new era of utilising waste in repair mortars is in line with the new demand for sustainable construction, without jeopardising the integrity and authenticity of historical buildings (Taglieri *et al.* 2017). In the case of mortars, traditional binders such as air lime, natural pozzolans, brick dust and clay have been combined successfully for the above-mentioned reason (Papayianni and Stefanidou 2007; Schafer and Hilsdorf 1993).

RESEARCH OF HISTORICAL MORTARS AS A BASIS FOR THE DESIGN OF REPAIR MORTARS

Knowledge about old techniques, materials and their performance, represents a solid foundation for conservation decisions (Álvarez 2020: 944; Talib *et al.* 2023; Schueremans *et al.* 2011: 4338-4339). Maintenance works include a series of complex actions and methods, the suitability of which is checked in the laboratory, but also with on-site test applications, which lead to an understanding of the problems and the design of the solutions required in each case.

Restoration respects the authentic character of the monuments, in all their historical transformations and is based on scientific studies. The character of the monument includes the matter, which is inherent in its image and its aesthetic character. The materials incorporated represent the technology of a different era. The restoration materials must be of high quality, compatible with the con-

struction material of the monument and distinguishable from the original historical materials. The term anastylosis refers to the complex work of restoring structures, which consist of independent architectural members and mainly includes the integration, in their original position, of existing members. The completeness of the operation is determined by the completeness of the documentation, the experience of the involved specialties and the quantity and quality of the new materials that are added to the construction.

A triple helix can be considered for any intervention works and includes the design and use of repair mortars: suitable materials selected, the environment under which the structure serves and the techniques used for the material application (Figure 3).

During previous decades, research on historical materials and structures has been focused on:

- An understanding of the performance of the components (binding materials, aggregates and additives).
- The elucidation of the old recipes and the methods of application to broaden the historical background on these previous cultures and to support the decision making for preservation.
- The technological characteristics of the mortars (the ratios and quality of the different raw materials, the application procedures, the characteristics of the substrates, and the specific climatic conditions), for ancient materials as well as for the repair ones.
- The durability of the materials under different surroundings (environmental factors, pollution and weather conditions).
- The incorporation of by-products in the mortars' composition without altering the basic properties and retaining the compatibility qualities.
- The methods of testing the different properties, their reliability and practical implementation (in situ and in lab conditions).
- The design and choice of the most suitable repair materials and the monitoring of their effectiveness.

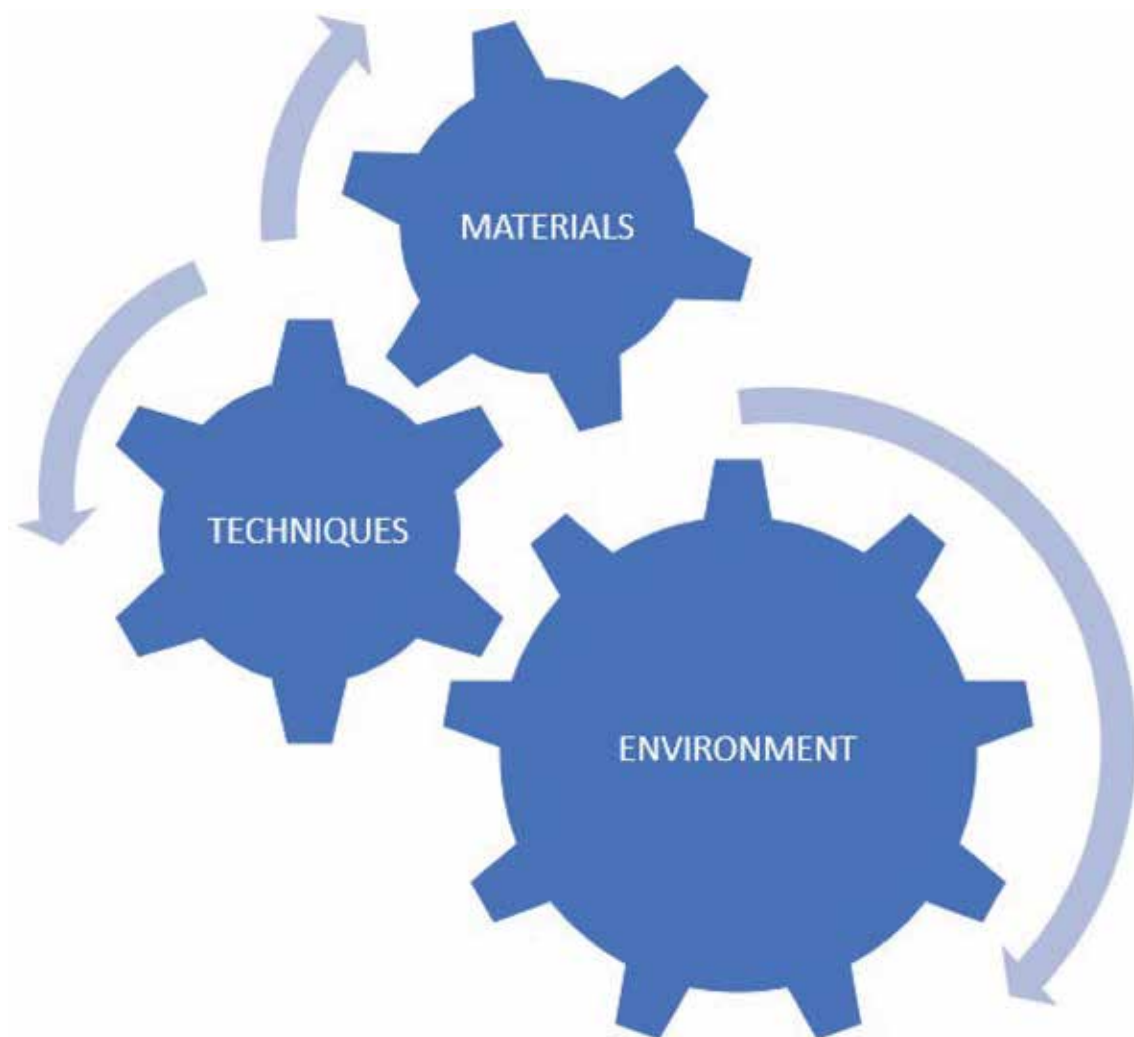


Figure 3. Parameters under consideration for mortar intervention (scheme made by the author).

The most common building material pathology symptoms are cracks, efflorescence, spalling, deformations, de-colorization, flaking, and depositions. Health monitoring of historical structures by integrating technologies can assist the understanding of the existing situation in synergy with optical observations in order to map the existing situation during restoration operations.

COMPATIBILITY ISSUES

The widely accepted concept of compatibility between an existing structure and new repair materials has not been clarified in technical terms up to now. The criteria for the suitability of the raw materials used for manufacturing these materials

are not adequate or well defined. There are no constitutional laws or basic relationships concerning the parameters that influence their performance. A manual of practice, including recommendations, instructions and simplified methods of checking, in situ, the manufacture and application of these mortars is necessary in restoration works. The lack of such a manual has a direct impact on the quality and cost of restoration work. Inappropriate repair mortar (not well designed and applied) results in additional loss of the original structure or aggravation of its pathology, which will require an additional repair intervention. In **Figure 4** a problematic intervention on masonry using cement-based materials is indicated. The result, beyond the aesthetic incompatibility, is also problematic in terms of functionality. It seems that



Figure 4. Problematic interventions with cement-based materials (photo by the author).

the decay of the authentic material is accelerated, while the impermeable cement remains.

In general, the cost of repairing monuments and historical buildings is much more than that of modern structures. Specific materials are not often available in the market (they are manufactured to order) and specialised technicians are needed for these works. In most cases of restoration projects, a study of the existing materials is not foreseen in the budget, or the cost allocation is very limited. Additionally, there are not many laboratories or research institutes that are able to undertake studies of this type. With regard to designing repair mortars, each laboratory or research centre follows its own methodology based on its previous experience. There are no protocols of repairing historical buildings and the situation is becoming increasingly urgent as each of these structures is unique. Monitoring systems by which the behaviour of repair mortars could be recorded do not exist in the field of restoration.

Almost in all preventive interventions, repair mortars are used. Despite the wide-ranging research and case studies that have been performed, there is still a gap between knowledge and prac-

tice in the conservation of monumental heritage. The design of lime-based repair mortar could be based on a scientific footing if a set of nomographs, regulations and a manual of practice were to be developed for users. There is also a need for the establishment of appropriate infrastructure in laboratories of the private and public sector for testing repair mortars. By following this policy, a direct impact could be made on both the cost and quality of repair works.

Some of the characteristics that distinguish the to-date resistant old lime-based mortars from the modern cement-based mortars (Papayianni and Stefanidou 2007: 356; Stefanidou and Papayianni 2005: 915; Papayianni *et al.* 2013: 89) are:

- Low apparent specific density (1.5 – 1.8);
- High porosity (20-40%);
- Low water retentivity and quick drying;
- High degree of compaction;
- Very good bond with substrate;
- Well crystallised matrix;
- Low compressive strength (<3MPa).

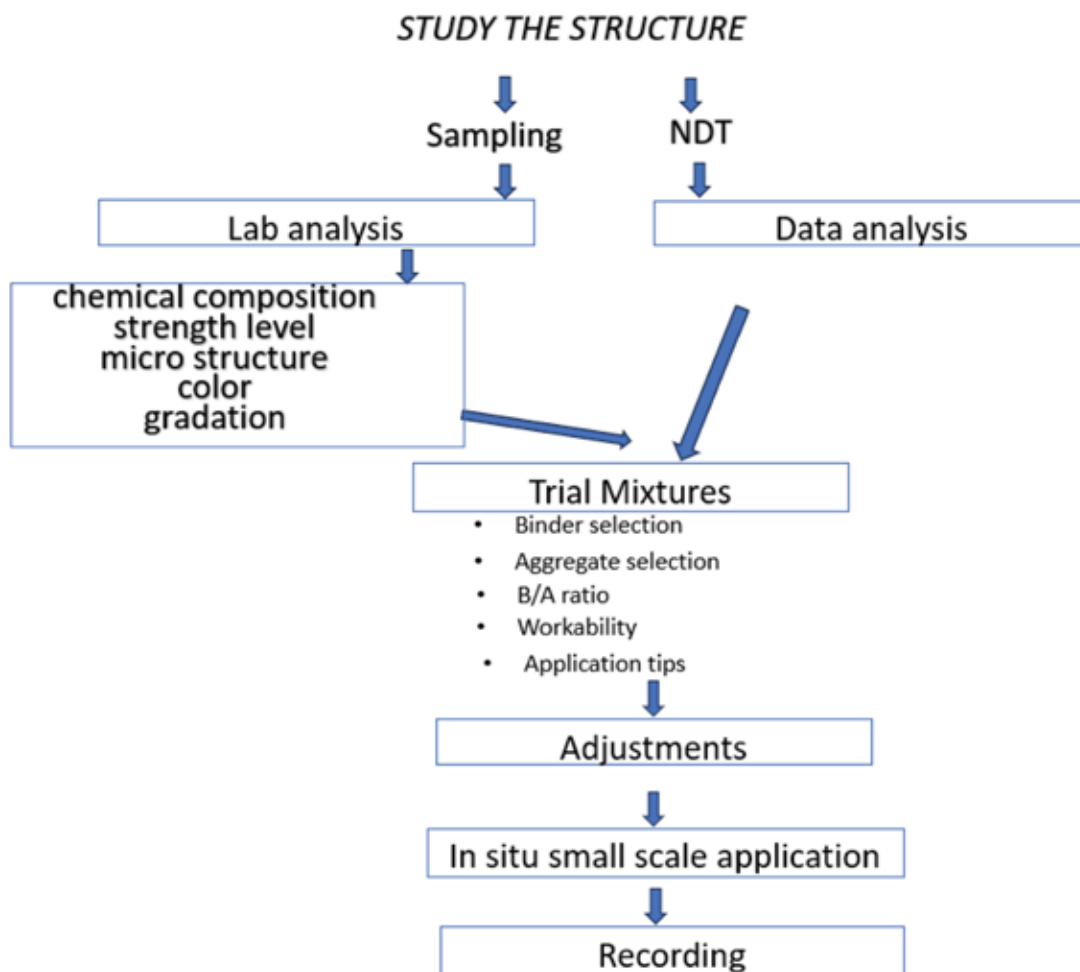


Figure 5. Schematic representation of the workflow (scheme devised by the author).

The pieces of information taken from the analysis of existing mortar (**Figure 5**) are: The type of binder; more than 40% content of CaO indicates lime mortar. An adequate quantity of reactive silica content usually implies a hydraulic component. For repair mortars, the quality of existing air lime is a significant topic that should also be taken into account (Veiga 2017: 133-136). The mineralogical origin of aggregates; their gradation and max aggregate size are parameters taken into account for the design of repair mortars. An estimation of strength level, based on site or laboratory measurements, is also a factor under consideration. Decisions are taken based on:

- the binding system. Here, among other things such as the fineness and the colour, we consider the environmental

background (resource availability) and the reactivity of available raw materials.

- the aggregates retaining the characteristics of origin, such as max size and granulometry. An improvement of gradation is possible to be made.
- the water quantity (determined according to the workability desired).
- the additives used for improving fresh/hardened properties (plasticity, porosity and strength).

The suitability of raw materials is tested in terms of physical chemical and, recently, on criteria based on sustainability. Afterwards, trial mixtures are made in the laboratory and the specimens are tested. Colour, strength and porosity are measured and some durability tests are carried out if necessary (exposition in different ageing envi-

ronments) (**Figure 5**). Sometimes, a pilot application on site is suggested for in situ adaptations.

During this procedure, a compatible material is defined based on the aesthetic harmonisation with the old structure without disturbing the behaviour of the original structure (in terms of hygroscopic, mechanical, structural, thermal and physical behaviour). At the same time, it should be effective (adequate early strength is developed for the work to progress) under the specific environmental conditions and it should be as resistant as possible to the mechanisms of deterioration.

The addition of a hydraulic component (pozzolan or a small amount of white cement) increases the strength and decreases the porosity. The quality (pozzolanicity) and the fineness of the pozzolan may increase the early and final strength considerably. The addition of up to 20% of white cement does not significantly decrease the porosity while increasing early strength (Papayianni *et al.* 2013: 88-92). Regarding the role of aggregates, care should be taken to synthesise an even aggregate gradation. The influence of aggregate content and of the binder/aggregate ratio on strength development of soft lime mortars is greater than that of lime-pozzolan mortars. This has been attributed to the weak transition zone created by large granules. The most important role of aggregates seems to be the decrease of creep and shrinkage deformation and the blocking of crack propagation which results in the stability of mortar volume. Compaction during application could significantly improve the strength and related properties of mortar. In field works, compacted mortar shows three times higher values of strength than that without compactness. Finally, the curing regime and period constitute a problem, especially for mixed type binding systems (Stefanidou and Papayianni 2005; Papayianni and Stefanidou 2007).

CONCLUSION

Intervention in historical structures is often a necessary procedure aimed at maintaining the structure and the mortars included in it. External factors (environmental issues) as well as inherent weakness (material issues) can act synergistically (or not) resulting in the urgent need for measures to ensure the safety of the structures. During pre-

vious decades, a lot of experience has been accumulated through different case studies where a variety of challenges had to be overcome. Many relevant papers have been published, and cooperation among researchers has assisted with the process of finding solutions. New challenges (such as the climatic crisis) should also be taken into consideration when developing intervention policies. Best practices have already been applied and cooperation among different disciplines, as well as among research teams, can provide effective solutions in the face of the many challenges that have arisen globally regarding these complicated issues of intervention regarding historical mortars and structures in general. Successful interventions are of benefit to both the buildings and modern societies.

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REZIME**IZAZOV USPEŠNE PRIMENE
MALTERA U ISTORIJSKIM
GRAĐEVINAMA**

KLJUČNE REČI: ISTORIJSKE STRUKTURE, MALTERI, ODRŽIVOST, KOMPATIBILNOST, METODOLOGIJA.

Sprovođenje tehničkih intervencija nad istorijskim građenim strukturama je često neophodno i podrazumeva različite postupke koji imaju za cilj da se ove strukture sačuvaju. Među njima se nalaze i oni vezani za pripremu i primenu maltera za konzervaciju.

Metodologija istraživanja istorijskih maltera i primene kompatibilnih maltera za konzervaciju bi trebalo da se zasniva na naučnim kriterijumima, a od izuzetne važnosti je i postojanje normativa u izvođenju samih radova na istorijskim strukturama. U planiranje uspešne intervencije u ovim strukturama danas su uključeni i novi izazovi, kao što su pitanja održivosti i cirkularna ekonomija.

Istraživači i konzervatori danas imaju mogućnost da iskoriste akumulirano iskustvo iz mnogobrojnih sprovedenih studija o istorijskim građevinama, kako bi učili iz prošlosti. Saradnja između pripadnika različitih naučnih i stručnih disciplina je ključni faktor uspeha u procesima očuvanja istorijskih građevina. Ova saradnja, uz vezu među istraživačkim timovima, može biti jedno od bezbednih rešenja za suočavanje sa svim izazovima koji se javljaju u složenim pitanjima intervencija vezanih za istorijske građevine, među kojima su i one koje podrazumevaju izradu maltera za konzervaciju, kako bi građevine bile sačuvane za buduće generacije.

* * *

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KUBERNETES AS AN APPLICATION MANAGEMENT PLATFORM

ABSTRACT

Kubernetes is a technology used to manage the deployment and scaling of applications in the cloud. It can enable automatic scaling of applications across multiple servers in order to ensure the applications are always running on the optimal number of resources. In addition, high availability is ensured by automatically redirecting traffic between servers. It could be useful in archaeology to manage the deployment of various applications for processing and analysing data from archaeological research. Kubernetes can improve application performance by making it easier to develop, test, and maintain containerised applications.

KEYWORDS: K8s, KUBERNETES, CLOUD, CONTAINER, APPLICATION MANAGEMENT PLATFORM.

INTRODUCTION

Kubernetes is one of the most important technologies today for managing applications and infrastructure. This open-source container orchestration system enables automatic deployment, scaling, resource management, and self-healing of applications, allowing focus on application development rather than infrastructure management. Kubernetes is often presented in the literature as “K8s” and actually represents a platform for managing and automating the deployment, scaling and management of applications. Originally designed by Google, it is now maintained by the Cloud Native Computing Foundation. It is commonly applied within an infrastructure as a service (IaaS), where it is used to automate processes associated with the deployment and management of containers, enabling easier development and maintenance of applications. Kubernetes can be deployed in many different situations, from small

single applications to large systems with hundreds or even thousands of containers. Kubernetes is used worldwide in many different industries, including finance, technology, telecommunications, manufacturing, and more.

One of the most common ways of using Kubernetes is to automate procedures linked to the deployment and management of applications within one or more computer clusters. The ability to automatically scale applications across multiple servers also enables automatic traffic redirection between servers to ensure high availability. Kubernetes can improve application performance by enabling easier development, testing and maintenance, and scaling of containerised applications.

As an open-source system, it can be used on different computers in the cloud or on other physical infrastructures. Kubernetes can be applied in various scenarios, including the development and maintenance of large web applications, container management, testing and production. One exam-

ple of using Kubernetes is to harness its capabilities to manage the deployment of containerised applications in large web services. This kind of implementation allows for an easier scaling of applications depending on changes in resource requirements, as well as a better utilisation of resources in case of load changes.

WHAT IS REQUIRED TO USE KUBERNETES?

In order to use Kubernetes, it is necessary to have at least one server running on the Linux operating system. Additionally, it is necessary to have experience in working with containers, as well as to have knowledge about networking, security and infrastructure. In practice, there are certain things necessary for the use of Kubernetes (Kubernetes 2023) (Burns, Beda and Hightower 2019):

- Infrastructure management system: Kubernetes can be used on a physical or a virtual system, so having an infrastructure management system that will support Kubernetes is essential. It can be a physical machine, a virtual machine, or a public cloud service, such as Amazon Web Services (AWS), Google Cloud Platform (GCP), or Microsoft Azure.
- Container management system: Kubernetes consists of a series of containers hosted on one or more servers. It is necessary to have a server to manage these containers and to ensure that they work together.
- Containers: Kubernetes uses containers to package applications and their dependencies. It is necessary to have ready-to-use containers in a Kubernetes environment. Containers can be system-based and application-based¹.

¹ System containers seek to emulate virtual machines and often initiate a full boot process. They often include a set of system services typically found in a VM, such as ssh, cron, and syslog. When Docker was new, these types of containers were much more common. Over time, they were considered bad practice, and application containers gained favour. Application containers differ from system containers in that they typically run a single program.

Nodes – computers on which the containers will run. Nodes must have some container manager (e.g., Docker) and Kubernetes agents installed (Kubeadm², Kubelet³ and Kubectl⁴). A node can be a physical or a virtual machine and can be hosted on-site or in the cloud. A Kubernetes cluster can have a large number of nodes, and with the latest versions supporting up to 5,000 (Shtein 2023). A Kubernetes node is actually a single machine in a cluster that serves as an abstraction. Instead of managing specific physical or virtual machines, each node is treated as a pooled CPU and RAM resource on which to run containerised workloads. When an application is deployed to a cluster, Kubernetes distributes the work across the nodes. Workloads can be seamlessly moved between nodes in a cluster (Shtein 2023).

Kubectl is a command line interface used to control the cluster (Saito, Chloe Lee and Carol Hsu 2018: 10).

A kubelet is a master process on a Kubernetes node that communicates with the Kubernetes master node to handle the following operations (Saito, Chloe Lee and Carol Hsu 2018: 12):

- periodically accesses the API Controller for verification and reporting;
- performs container operations;
- runs an HTTP server to provide simple API.

[~]\$kubectl get nodes -o=wide (see Table 1)

Kubernetes master node: Master node manages the Kubernetes cluster and is used to manage the data and configurations of the containers in the cluster.

Kubernetes worker nodes: Worker nodes are machines available to run containers in the cluster.

Kubernetes API: The Kubernetes API server

While running one program per container may seem like an unnecessary limitation, it provides the perfect level of granularity for building scalable applications (Burns, Beda and Hightower 2019).

² Kubeadm is a command-line tool that simplifies the process of setting up and managing Kubernetes clusters.

³ Kubelet is a technology that deploys, creates, updates and removes containers on a Kubernetes node.

⁴ Kubernetes CLI tool (Kubectl) – this tool allows you to manage a Kubernetes cluster via a command line.

[~]\$kubectl get nodes -o=wide

NAME	STATUS	ROLES	AGE	VER	INT-IP	EXT-IP	OS-IMG	KERNEL-VER	CONTAINER-RUNTIME
vmss000002	Ready	agent	21d	v1.22.11	10.163.4.62	<none>	Ubuntu 18.04.6 LTS	5.4.0-1090-azure	containerd://1.5.11+azure-2
vmss000003	Ready	agent	11d	v1.22.11	10.163.4.4	<none>	Ubuntu 18.04.6 LTS	5.4.0-1090-azure	containerd://1.5.11+azure-2

Table 1. Information about nodes

allows programs to communicate with the Kubernetes master node and to manage containers in the cluster. The API server actually represents the Kubernetes central station. All communication between all components must go through the API server, which means that all internal system components, as well as external user components, communicate through the same API. In it, the desired state of the application is defined through the configuration. This includes: choosing the container image to use, choosing open ports and the number of Pod replicas to run. All requests to the API server are subject to authentication and authorisation checks, but once these are done, the

configuration YAML database becomes validated, included in the cluster repository, and deployed to the cluster (Poulton and Joglekar 2020: 2020: 14)

K8s - ADDITIONAL COMPONENTS AND SOME COMMANDS

Kubernetes then has a whole range of components, including PODs, services, volumes, Scheduler and other components that are necessary for the functioning of Kubernetes, as well as a Kubernetes dashboard tool that allows you to visually monitor and manage a Kubernetes cluster through a web interface. A Kubernetes POD is the smallest management unit in a Kubernetes cluster. A pod includes one or more containers, and operators can attach additional resources to the pod, such as storage volumes. A pod has its own IP, allowing pods to communicate with other pods on the same node or other nodes (Shtein 2023).

[~]\$ kubectl get pods -o=wide (see Table 2)

[~]\$kubectl get pods -o=wide

NAME	READY	STATUS	RESTARTS	AGE	IP	NODE
agent	1/1	Running	0	5d19h	10.163.4.6	vmss000003
debug	1/1	Running	1	5d1h	10.163.4.10	vmss000003
eureka-0	1/1	Running	0	11d	10.163.4.73	vmss000002
kowl-ui	1/1	Running	0	4d21h	10.163.4.23	vmss000003
notifications	1/1	Running	0	4d20h	10.163.4.12	vmss000003

Table 2. Information about PODs

This command does not display all PODs located on the system. There are PODs that are part of the system itself. It often happens that ISP or cloud providers add their own pods, which are poorly or even not documented. In order to see Azure specific PODs, the following command is used: `[~]$kubectl get pods -o=wide -A`.

Kubernetes Scheduler runs on the master node and is responsible for searching for eligible worker nodes for each POD and placing it on those nodes. Each POD has a template that defines how many instances of the module should be run and on which types of nodes. If a node fails or does not have enough resources to run a module, the module is dropped and restarted on another node (Shtein 2023).

Services are also important components of Kubernetes. Care should be taken here regarding terminology, since there are some terms that intersect, for example, when someone says service (this means Software as a service (or SaaS) or the port on which the application will work). In this sense, a service can mean a set of PODs that is necessary for some SaaS. Therefore, in Kubernetes terminology, it can be said that services represent services for the logical grouping of a set of PODs, which is necessary to provide network connectivity (Microsoft Learn 2023). The following service types are available (Microsoft Learn 2023): ClusterIP, NodePort, LoadBalancer and ExternalName. According to Google, there is also a fifth, the so-called Headless (Google Kubernetes Engine (GKE) 2023).

With the ClusterIP service, internal clients send requests to a stable internal IP address. With the NodePort service, clients send requests to the IP address of the node at one or more NodePort values specified by the service. The NodePort type is an extension of the ClusterIP type. Hence, a service of the NodePort type has a cluster IP address.

With the LoadBalancer service, clients send requests to the IP address of the network load balancer. The LoadBalancer type is an extension of the NodePort type. So, a service of the LoadBalancer type has a cluster IP address and one or more NodePort values. With the ExternalName service, internal clients use the service's DNS name as an alias for the external DNS name. When it comes to the Headless service (only with Google), this type of service can be used when you want to group

PODs, but you do not need a stable IP address.

In Kubernetes, there are several different port configurations for Kubernetes services (Merron 2020):

- Port – exposes a Kubernetes service on the specified port within the cluster. Other PODs within the cluster can communicate with this server on the specified port.
- TargetPort is the port to which the service will send requests through which your module will listen. Your application in the container will also need to listen on this port.
- NodePort externally exposes the service to the cluster using the IP address of the target nodes and the NodePort. NodePort is the default setting if the port field is not specified.

BASIC STEPS FOR CONFIGURING KUBERNETES

Configuring Kubernetes involves several steps, including installing a Kubernetes cluster, configuring the network, setting up security, and installing additional components.

The first step is installing a Kubernetes cluster. This step involves installing the Kubernetes master and worker nodes. Kubernetes master controls the entire cluster, while worker nodes work with applications. Configuration files for various Kubernetes components (e.g., API server, Scheduler, etc.) are set there.

The second step is to configure the network. It is necessary to set up the network so that applications and containers can communicate with each other and with the outside world. This is also where the options for scaling and maintaining the cluster are set (e.g., resource management, container allocation, etc.).

Kubernetes can monitor PODs and scale them when CPU utilisation or some other metric exceeds a threshold. The autoscaling resource specifies the details (CPU percentage, how often to check) and the appropriate autoscaling controller adjusts the number of replicas, if necessary (Sayfan 2017: 215) (**Figure 1**).

The third step is to set the security. It is necessary to ensure the security of the Kubernetes cluster, by using authentication, authorisation and

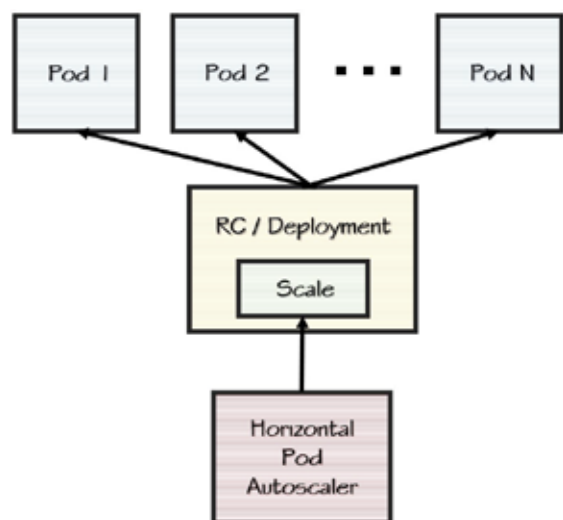


Figure 1. Horizontal POD autoscaling (figure made according to Sayfan 2017: 216).

encryption of data and other security measures. In order to increase security when using Kubernetes, there are several important actions that should be taken. Firstly, it is necessary to ensure that Kubernetes is installed with security settings according to the manufacturer's recommendations. This includes using security keys to authenticate and encrypt data, as well as ensuring that all network connections are secured. Secondly, ensure that all applications and services deployed through Kubernetes are regularly updated to prevent vulnerabilities. This can be achieved through automated updating and patching processes. Thirdly, it is necessary to ensure that users and resources within the Kubernetes environment are controlled according to the principle of "least privilege". This means that users are granted only those rights that are necessary for them to perform their tasks, and all other privileges are disabled. Additionally, it is necessary to implement controls for monitoring and auditing work within Kubernetes.

Implementing monitoring and auditing controls in a Kubernetes environment is important for several reasons. On the one hand, it allows monitoring of the operation of applications in real time and reacting immediately to possible problems or errors. On the other hand, it is possible to monitor the correct operation of the applications (in the sense of whether they behave in accordance with the set goals and expectations). This way, the auditing of the application operation is performed, which is important for achieving a high level of

security and reliability in the operation of applications. Implementation of control for monitoring and auditing work in Kubernetes environment can be done in different ways, depending on specific requirements and needs. However, this is mostly done using different tools and technologies, such as Prometheus⁵ (Wilson 2023), Fluentd (Fluentd 2019)⁶, Elasticsearch (Jetha 2020)⁷ and Kibana (Elastic 2023).

The fourth step is to install additional components. This step involves installing additional components, such as ingress controllers, volume managers, monitoring and others. These components allow the functionality of Kubernetes to be improved and adapted to the specified needs.

Configuring Kubernetes involves setting various options and parameters to enable Kubernetes to work properly and to be tailored to the needs of an organisation. After configuring the Kubernetes cluster, it is possible to use various tools and services to manage and develop applications on the cluster. This includes working with the Kubernetes API, creating and managing containers, and creating and maintaining Deployments and other objects in the cluster.

When it comes to technologies related to container management, Docker can also be found in the literature in addition to Kubernetes. Although both technologies are related to container management, there are some fundamental differences between them. Docker was originally a container platform that allowed development teams to package applications into containers and distribute them easily.

Kubernetes, on the other hand, is a platform for automating the deployment, scaling and management of containers on clusters of computers. Kubernetes allows development teams to deploy applications to different computers in a cluster, as well as to automatically adjust the number of application instances depending on the load. It can be said that Docker serves as a tool for packaging ap-

⁵ Prometheus is a highly scalable open-source monitoring framework. It provides out-of-the-box monitoring capabilities for the Kubernetes container orchestration platform.

⁶ Fluentd is a logging agent that takes care of collecting, parsing and distributing logs.

⁷ Elasticsearch is typically used to index and search large amounts of log data, but it can also be used to search many different types of documents.

plications into containers, while Kubernetes serves as a tool for managing containers on computer clusters. Kubernetes is, in fact, integrated with Docker and can be used to manage containers that are created in Docker. Therefore, if you need to automate the management of applications in containers on multiple computers, Kubernetes could be a good choice, while Docker could be a good choice if you need to simply pack an application into a container.

USE OF KUBERNETES

Kubernetes offers efficiency in a number of ways. Firstly, it enables the easier management of large numbers of containers and automates many of the routine tasks required to maintain applications. This includes load balancing, resource allocation and scaling applications according to needs. Secondly, Kubernetes makes it easier to maintain applications in production. This means the ability to start and stop applications quickly, to maintain them easily, and to develop new versions more easily, without interruption. Together, this can increase efficiency and reduce the time required to maintain applications in production.

Kubernetes is designed to help developers and administrators build, deploy and manage distributed systems at scale, and provides a range of features and tools to help with this (Kubernetes 2023), including (Burns, Beda and Hightower 2019):

- Automatic deployment and scaling of applications, based on declarative configuration files.
- Self-healing capabilities, for automatic replacement of faulty or defective containers (Lukša 2020).
- Service discovery and load balancing to make it easier for containers to communicate with each other and access external resources.
- Storage orchestration, to automatically manage storage resources used by containers.
- Rollout and rollback, to facilitate application updates without downtime.
- Multi-tenancy and resource allocation, in order to run multiple workloads on the same cluster and allocate resources to them as needed.

The usefulness of Kubernetes can be seen in the case when there is an application that consists of multiple containers and a reliable and efficient way to manage those containers is needed. It is Kubernetes that enables the automation of many tasks related to container management, including the deployment and scaling of containers, maintaining the security and availability of the application, and maintaining the correctness of the application in case of errors (Lukša 2020).

Kubernetes is used in various industries and situations where a large number of computers and applications need to be managed. This includes managing servers in large organisations, as well as in the cloud and on-site systems. It is also used to develop and manage large and distributed data processing systems, as well as to manage applications in various environments, including those used in IoT devices. Kubernetes is also applied to manage and automate work with various resources in cloud environments, including containers, virtual machines, databases and other infrastructure solutions. It should be mentioned that Kubernetes is already used by all major cloud vendors like AWS, Azure, and Oracle Cloud Infrastructure. They all have their own services for managing Kubernetes clusters on their platforms. In AWS (AWS) it is called Amazon Elastic Kubernetes Service (EKS), in Azure (Azure) it is called Azure Kubernetes Service (AKS) and in Oracle Cloud Infrastructure (OCI), its name is Oracle Kubernetes Engine (OKE).

Kubernetes is additionally used in the development and maintenance of various types of applications, from simple web applications to complex micro services and server-less solutions. Each micro service is a separate application with its own development cycle. When a system consists of many micro services, automated management is crucial. Kubernetes provides exactly this automation. The features it offers ensure that the task of managing hundreds of micro services is almost trivial (Lukša 2020). Kubernetes will enable faster and more efficient application development, as well as easier maintenance and scaling of applications according to needs.

Kubernetes and archaeology

Kubernetes is a technology used to manage

the deployment and scaling of applications in the cloud as well. It could be useful in archaeology to manage the deployment of various applications for processing and analysing data from archaeological surveys. Archaeological surveys often produce large amounts of data, including 3D models, geographic information, photographs, records and other relevant information. For example, applications processing photos or geolocation data can be deployed over Kubernetes to ensure that they are always available and capable of processing large amounts of data. Kubernetes can be used to manage all that data, as well as to facilitate the deployment and sharing of data with relevant researchers, archives and other organisations. However, data security should be taken into account in such a situation. One of the examples of the use of Kubernetes technology in the management of archaeological sites is the creation of an application (MyPompeii) (Pompeii Sites) by the Archaeological Park of Pompeii during the Covid-19 pandemic, which was used to help tourists adhere to social distancing protocols through a real-time map (Gutierrez 2021).

Another example of its application in archaeology could be the use of Kubernetes to manage archaeological simulations and models. Archaeological models are complex and require a large amount of computing power to run them. Kubernetes can be used to automatically scale the computing power required to run these models, as well as to manage the containers required to run the simulation.

Considering methods to store archaeological data using systems like Kubernetes can be tailored to the specific needs of archaeological research. Here are some of the methods used and details on how to implement this process:

Utilizing Microservices Architecture: Kubernetes enables the implementation of microservices, meaning different aspects of archaeological data can be stored in separate services. For example, you could have a microservice for storing information about sites, another for artifacts, and so on. This facilitates system scalability and maintenance.

Using Object Storage Resources: Instead of traditional databases, you could explore the use of Object Storage resources for storing large amounts of archaeological data, including images, scans, and other multimedia records. Object Stor-

age can be efficient for storing unstructured data.

Implementing Blockchain Technology for Auditing: Consider the use of blockchain technology for storing an audit trail of changes and access to archaeological data. This can add a layer of transparency and integrity to the data, ensuring that unauthorised changes do not occur.

Automating Data Backup and Archiving: Configure Kubernetes to automatically perform backup and archiving of archaeological data. This ensures that data is regularly backed up, making it resilient to the loss of information due to unexpected events.

Adapting Resources to Project Needs: Kubernetes allows dynamic resource adaptation based on the current needs of the system. This is particularly useful for archaeological projects that may experience changes in data volume over time. For instance, resources can be automatically scaled during intensive data collection periods.

These ideas can serve as a starting point for contemplating innovative approaches to storing archaeological data using Kubernetes systems while adhering to security and reliability standards. It is important to tailor these ideas to the specific requirements of archaeological research.

CONCLUSION

Kubernetes is a useful tool for managing the deployment and maintenance of applications in the cloud and other environments, which helps optimise resources and enables the easier scaling of applications. It represents a unique and useful platform for managing various applications. It is used worldwide in many different industries, including finance, technology, telecommunications, manufacturing, and more. Its usefulness in the form of automated deployment and scaling of applications enables easier work with large systems. It is designed to automatically replace non-functional containers, increasing the stability and reliability of the system. It enables discovery and load balancing, which greatly simplifies communication between containers and access to external resources. When it comes to resource management, resource orchestration is provided, which means that it automatically manages the resources used by applications. Additionally, Kubernetes allows simple updating of applications without

downtime, which enables the smooth operation and improvement of the system.

In archaeology, Kubernetes could be used to manage databases in a way that allows for an easier deployment and scaling of databases across multiple servers, which would facilitate data access and processing in research. It could also be used to automate the process of backing up and restoring databases in the event of a failure.

From all of the above, it can be seen that Kubernetes can be used in many different contexts, including large and small organisations, different industries and cloud platforms, and considering the fact that it enables the efficient design, deployment and management of scalable systems, it represents an extremely useful tool in the administration of complex systems.

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REZIME

KUBERNETES KAO PLATFORMA ZA UPRAVLJANJE APLIKACIJAMA

KLJUČNE REČI: K8s, KUBERNETES, CLOUD, CONTAINER, APPLICATION MANAGEMENT PLATFORM.

Kubernetes je tehnologija koja se koristi za upravljanje raspoređivanjem i skaliranjem aplikacija u oblaku. Kao korisno oruđe za upravljanje raspodelom i održavanjem aplikacija u oblaku i drugim okruženjima pomaže u optimizaciji resursa i omogućava lakše skaliranje aplikacija. Skaliranja aplikacija mogu biti primenjena na više servera, kako bi se obezbedilo da se one uvek pokreću na optimalnom broju resursa. Dodatno, automatskim preusmeravanjem prometa između servera, obezbeđuje se visoka dostupnost. Tehnologija Kubernetes bi mogla biti korisna i u arheologiji, i to za upravljanje raspoređivanjem raz-

ličitih aplikacija za obradu i analizu podataka iz arheoloških istraživanja.


Kubernetes može da unapredi rad aplikacija tako što omogućava lakši razvoj, testiranje i održavanje kontejnerizovanih aplikacija. Benefit njegove upotrebe ogleda se u tome što se može primeniti u mnogim različitim kontekstima, uključujući velike i male organizacije, različite industrije i cloud platforme, a s obzirom da omogućava efikasan dizajn, deploy-ovanje i upravljanje skalabilnim sistemima, predstavlja izuzetno koristan alat u administriranju složenih sistema.

* * *

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FIRST HALF OF THE FLOW PROJECT – METHODS, PRACTICES AND FIRST RESULTS

ABSTRACT

The paper summarises the results achieved during the first 18 months of the project THE FLOW (Interactions-Transmission-Transformation: Long-distance connections in Copper and Bronze Age of the Central Balkans). The project team has visited 12 museums in the territory of Central Serbia and accumulated a total of 5,000 km of road trips. More than 400 pottery samples from 67 archaeological sites were collected for provenance analyses, thermoluminescence and optically stimulated luminescence dating. Samples have also been collected from more than 150 bronze and 64 copper artifacts, as well as more than 25 samples from clay pits and ore deposits.

A total of 30 samples from obsidian artifacts have been collected. Following the collection of samples, procurement procedures were conducted for AMS and TL/OSL dating, as well as calls for isotopic analyses of copper and tin provenance. Contracts for TL/OSL analyses have been signed with Instituto Universitario de Geología “Isidro Parga Pondal” from La Coruña (Spain), and for AMS analyses with Isotopech Zrt. from Debrecen (Hungary), and Rutgers University in New Jersey (USA).

Laboratory research within the project has so far brought many important results, among which are those on the origin of the raw materials for making the analysed ceramic vessels, as well as the pigments used for their decoration. Extremely significant data was obtained on the composition of the analysed items made of metal - weapons and jewellery, on the basis of which preliminary conclusions were

made about the technology of their production, and them belonging to a certain region or workshop.

The project initiated the creation of a network of scientific collaborations that can be continued through future joint projects and applications on international calls. The following project activities will be aimed towards the consolidation of already established methodological procedures as well as the interpretation of the awaited outcomes and their integration into explanatory models of complex processes in the societies in later prehistory.

KEYWORDS: POTTERY, COPPER, BRONZE, OBSIDIAN, PROVENANCE STUDIES, ISOTOPIC ANALYSES, ABSOLUTE DATING.

INTRODUCTION

The inspiration behind THE FLOW project was grounded in the rising number of confirmations that the communities of later prehistory lived in a dynamic world, which swiftly changed through the circulation of people, material goods, and ideas. In archaeology, imports are traditionally recognised as objects whose physical appearance and characteristics single them out from the corpus of local materials. Such objects, found within archaeological contexts, are observed as a result of the exchange/trade of finished products and/or raw materials. Although the stylistic and typological analyses of presumably non-local objects represent the main methodological procedure, THE FLOW project has set up a multidisciplinary research framework for their systematic examination, with the utilization of state-of-the-art methods both in archaeology and science, with a particular focus on the origin, spatiotemporal distribution and analyses of networks of contacts. The research programme of the project was formed with the goal to study the origin and mechanisms of circulation of selected artifacts made of copper, obsidian, pottery, and bronze, throughout the Copper and Bronze Age, which originated from reliable archaeological contexts from key sites.

Spatio-temporal models were selected as the analytical framework to model the absolute dates of sampled objects and the disposition of raw materials, previously collected by the application of innovative analytical procedures. An attentive reconsideration of traditional archaeological and anthropological theoretical scopes regarding long-distance connections will serve as a base for the proposal of new models of interactions between prehistoric populations of South-eastern

and Central Europe, from a Central Balkans perspective.

The formation of a database that serves as a reference collection of provenance analyses of artifacts and raw materials, and information on their archaeological context and radiocarbon dates, will represent a contribution to solving the long-standing problems of regional archaeology. Results achieved so far, integrated into a unique system with the currently ongoing research, will offer a new insight into the nature and direction of connections that had a significant impact on the formation of social transformations in the later prehistory of the Balkans (Bulatović *et al.* 2022).

In the first 18 months of the project, the team has visited 12 museums in the territory of Central Serbia and accumulated a total of 5,000 km of road trips. Furthermore, more than 400 pottery samples from 67 archaeological sites were collected for provenance analyses, thermoluminescence and optically stimulated luminescence dating. Samples have also been collected from more than 150 bronze and 64 copper artifacts (**Figure 1**), as well as more than 25 samples from clay pits and ore deposits. A total of 30 samples from obsidian artifacts have been collected. Following the collection of samples, procurement procedures were conducted for AMS and TL/OSL dating, as well as calls for isotopic analyses of copper and tin provenance. Contracts for TL/OSL analyses have been signed with Instituto Universitario de Geología “Isidro Parga Pondal” from La Coruña (Spain), and for AMS analyses with Isotopech Zrt. from Debrecen (Hungary), and Rutgers University in New Jersey (USA). Two out of three of the aforementioned institutions had no previous scientific collaboration with the Institute of Archaeology in Belgrade and, therefore, THE FLOW project initiated the creation of a network



Figure 1. Sampling of copper and bronze artifacts at the National Museum, Šabac (photo from the archive of the project).

of scientific collaborations, that can be continued through future joint projects and applications on international calls (e.g., Horizon EU).

PREHISTORIC POTTERY IN FOCUS

In terms of the case study of the origin of raw materials, and the production and utilisation of pottery, the first methodological steps implied the formation of a database (bibliographic prospecting and data on unpublished materials), the collection and stylistic, typological and chronological analyses of pottery, and the preparation of samples for the following analytical procedures.

Collected, processed and prepared pottery samples come from Bronze Age sites in the territory of Serbia: Sokolica in Ostra and Slatina in Gornja Gorevnica from the collection of the National Museum in Čačak, and Židovar in Orešac from the archaeological collection of the Faculty of Philosophy of the University of Belgrade and the City Museum of Vršac. Regarding the complex procedure for determining the origin of pottery, which includes the comparison of similarities between artifacts from archaeological contexts, comparisons of the material composition of a specific group of potsherds and a comparison

with the clay source in the vicinity of the site, clay samples were collected from the sites of Židovar, Sokolica, and Slatina.

The aforementioned sites were selected for this case study based on several specifics. The site of Židovar holds a dominant position in the south of the Pannonian Plain (**Figure 2**) and with its multi-layered character of a *tell* settlement (Ljuština 2013: 101–112), provides a good possibility for research into the prevalence of traditional methods and/or innovation in the process of pottery production during the Early and Middle Bronze Age. Furthermore, the site provides insight into specific artifacts that reached the site through trade and exchange networks on both regional and supra regional levels. The comparative study on the provenance of raw materials will allow for the recognition of local specifics in clay preparation. The practice of a similar, yet specific, method of clay preparation has been recorded for Middle Bronze Age pottery workshops in southern Pannonia, and at other sites attributed to the Vatin culture (Gómez-Gras *et al.* 2021: 71–92).

In contrast to Pannonian *tell* settlements, which flourished during the first half of the 2nd millennium BCE (Љуштина 2022: 37–51), contemporary settlements in the territory of Central and western Serbia are practically “invisible” and



Figure 2. Židovar in Orešac (photo by Marija Ljuština, documentation of the University of Belgrade – Faculty of Philosophy, Department of Archaeology).

poorly researched. Sokolica in Ostra (**Figure 3**) and Slatina in Gornja Gorevnica (Dmitrović and Ljuština 2021: 155; Љуштина 2022: 140–146) represent two of the few settlements from the West Morava region, which highlights the importance of data on Bronze Age pottery production. Typical Middle Bronze Age pottery recorded in the settlements of Ostra and Gornja Gorevnica



Figure 3. Sokolica in Ostra (photo by Katarina Dmitrović, see also in: Ljuština and Dmitrović 2023: forthcoming).

can be attributed to the Bubanj-Hum IV-Ljuljaci cultural domain (Bulatović 2021: 136–143). Such an attribution does not exclude the possible influence of the ceramic production of the Vatin cultural domain on the production and the stylistic development of Bubanj-Hum IV-Ljuljaci pottery.

During the 1980s, Middle Bronze Age cemeteries with incinerated deceased were recorded in the territory of present-day cities of Bor and Zaječar in eastern Serbia. In contrast to Bronze Age communities of the Pannonian Plain, communities of the given territory were particularly focused on copper exploitation in the richest ore-bearing area in the Balkans (Вујадиновић 1953: 56; Jovanović 1980; Jovanović 1982; Pernicka *et al.* 1993; Petković 2009; Mehofer *et al.* 2021). THE FLOW project includes thermoluminescence analyses of ceramic urns previously dated by the ^{14}C method, which originated from enclosed contexts from the Trnjane and Hajdučka Česma necropolises near present-day Bor.

In the course of the excavation campaign at the site of Velika Humska Čuka (Mladenović *et al.* 2023), in July 2022, members of the project team conducted in-situ analyses of reconstructed vessels from the collection of the National Museum in Niš. The analysed vessels (**Figure 4**) were selected based on their specific forms and decoration. Besides in-situ measurements, the team applied an analytical procedure to determine the elemental composition of the pottery using a portable EDXRF spectrometer applied to the vessel body. In contrast to the analyses of previously prepared



Figure 4. Analysis of the vessels from the Velika Humska Čuka site using the EDXRF spectrometer in the depot of the National Museum, Niš (photo from the archive of the project).

sherds, this analysis was conducted on the existing damage of the vessel, by selecting the most suitable spots. Additionally, clay samples collected from two different locations in the vicinity of Velika Humska Čuka were analysed. Based on the analyses of the elemental composition of both the reconstructed vessels and clay samples (detected chemical elements are Si, K, Ca, Ti, Mn, Fe, Rb, Sr, Y, and Zr), a high degree of similarity has been determined (more than 90 per cent according to the hierarchical cluster method). Hence, it can be concluded with a high probability that the vessels were made from local raw clay. The determination of local production includes the analyses of pigments used for the decoration of ceramic vessels. The most interesting example is the motif of a “dancer” painted with red pigment. The EDXRF spectrometric technique determined that cinnabar was used for painting, which is usually rarely used for the decoration of ceramic vessels. By determining the presence of characteristic

trace elements in pigments, the origin of the raw material can be determined as well. The analyses indicated the presence of chrome (Cr), which is characteristic of cinnabar ore at Avala Mountain (Mladenović *et al.* 2023). Besides Avala Mountain, there are several cinnabar deposits that lie in the proximity of the site, such as the area between Breznica and Veliki Trnovac on the slopes of Kozarnik Mountain north of Bujanovac, and deposits in the vicinity of Gornji Milanovac on the slopes of Suvobor Mountain, near the village of Ozrem (Vukanović i dr. 1977: 42–44; Filipović i dr. 1978: 55–56). Therefore, the local origin of cinnabar pigment for the “dancer” motif can be speculated once further analyses are conducted on the local cinnabar deposits. On the other hand, if the origin of cinnabar for the “dancer” motif from the site of Velika Humska Čuka is confirmed to be Avala Mountain, there is a potential to provide new interpretations on the possible procurement of cinnabar from distant locations.

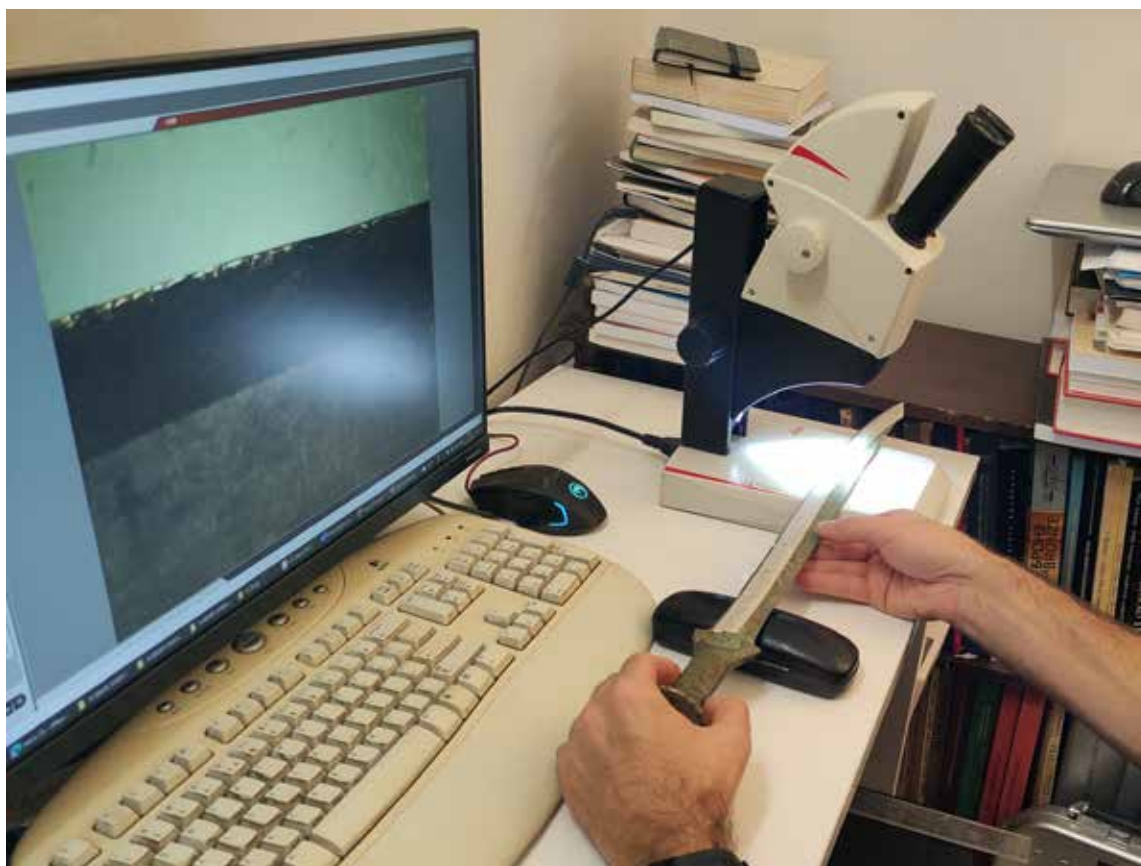


Figure 5. Use-wear analysis of the sword using the Leica EZ4 HD Digital Stereo Microscope (photo from the archive of the project).

A NEW INSIGHT INTO ARMS AND FASHION

One of the particularly interesting artifacts for the results of the project is a new find of an exceptionally rare type of bronze sword with a fully cast oval handle and three parallel grooves (the so-called *Dreiwulstschwerter* type) (Миладиновић, Булатовић и Филиповић 2023)¹. The sword underwent X-ray imaging and XRF analyses at the Vinča Institute of Nuclear Sciences, samples for copper and tin isotopic analyses in the USA were collected, and the blade also underwent use-wear analysis (**Figure 5**). The preliminary XRF analyses indicated that the sword has the purest bronze alloy compared to other artifacts analysed within THE FLOW project (Cu - 90.93%, Sn - 8.26%, Total - 99.19%). Furthermore, it should be highlighted that this example represents the first find

of this type south of the Sava and Danube rivers, dated to a relatively short period between 1200 and 1100 BCE (Ha A1 period). Certainly, the territory of origin of this object lies north of the Alps, and it was brought to the Central Balkans during the large-scale shifts and transformations in the Danube region and the Balkans during the transitional period (Ha A1).

Elemental analyses were also conducted on one of the fresh samples discovered at the site of Velika Humska Čuka near Niš during the 2022 excavation campaign. The samples, in fact, represent a hoard of bronze jewellery comprised of 22 pieces – 10 pieces of spirally twisted bronze wire (*saltaleone*), 10 bronze circular pendants with a knob in the middle, a bronze pin, and a thin bent bronze band. Several pieces from the hoard were analysed for chemical composition by a portable XRF spectrometer at the Vinča Institute. The analyses have shown that almost all of the analysed pieces have a similar chemical composition, based on tin-bronze, possibly made from the same

¹ The find is exhibited in the National Museum of Kruševac.



Figure 6. THE FLOW at the 65th International Fair of Technics and Technical Achievements, in Belgrade (photo from the archive of the project).

source of copper. Further insight into the chemical composition of the samples indicated that the pendants from this set of jewellery possibly originate from the same cast and workshop.

TOWARDS BETTER COMPREHENSION AND VISIBILITY OF RESULTS

Following the installation of the portable XRD instrument by the authorized service and the accompanying training, the team of the Vinča Institute started using the equipment. The development of analytical procedures was accompanied by the creation of a manual for the portable XRD spectrometer. Besides being a translation of the original manual, it contains other parameters significant for handling the device, analytical procedures, and for the interpretation of results, all considered important for further use by the team of authors from the Vinča Institute. With such experience, a planned training session was held for colleagues from the Institute of Archaeology in Belgrade. Colleagues were presented with the modes and possibilities of the instrument, all aspects of the analytical procedures, the methods by

which those analyses can be applied to cultural heritage, and the possible outcomes and results. THE FLOW project includes the processing of a large number of objects made of different materials through various analytical techniques, which will inevitably generate a large amount of different data and results. In line with that, a database is being created, enabling the availability and easily searchable access to all data, in order to provide better connections between the generated results. It will be the first open-access database in the region that unifies archaeological data and data acquired through techniques applied in natural sciences.

At the request of the Ministry of Science, Technological Development and Innovation, researchers from the Institute of Archaeology and members of THE FLOW project participated at the 65th International Fair of Technics and Technical Achievements, held in Belgrade between the 17th and the 19th of May (**Figure 6**). Team members introduced visitors to project details and demonstrated various instrumental techniques applied in provenance analyses of pottery and metal artifacts. The demonstration included a stand with different instruments (pXRF, XRF, FTIR) and a

background film with the achieved results and planned project dynamics.

At the end of 2022, one of the team members was invited to the International Scientific Conference – 75th Jubilee of the Institute of Art History and Archaeology of the Ss. Cyril and Methodius University in Skopje, and presented a new hoard of bronze jewellery from the vicinity of Požarevac, whose inventory indicates possible influences and imports in the Braničevo region (Filipović and Jacanović 2022). Further data will be available following the analysis of samples that have been sent to the laboratory.

Within the Annual Assembly of the Serbian Archaeological Society, an international assembly, members of THE FLOW project presented two reports that included the results of the project, such as physical and chemical analyses of bronze artifacts and questions about their origin and distribution. At the annual presentation within the Institute of Archaeology, held traditionally at Viminacium, the members of THE FLOW project presented two additional reports. One of the reports detailed the latest finds from the systematic archaeological excavations at the site of Velika Humska Čuka near Niš. Specifically, the report was based on the typo-chronological analysis of bronze finds, which will undergo isotopic and material analyses. THE FLOW project, all of its aspects, from administration and techniques to scientific results, were presented separately to all of the employees and guests of the Institute of Archaeology.

In the course of the second quaternary period, an opportunity was taken to participate in international training in the application of non-destructive radiographic methods on cultural heritage (Training Course on Radiography for Cultural Heritage Preservation, Valetta, Malta, 13-17.06.2022.) (Zammit and Gambin 2023: 34–35). The participation in training was completely funded by the International Atomic Energy Agency (IAEA) in Vienna. The training resulted in additional knowledge that can be applied to the project. Details of THE FLOW project were given during the presentation part of the training, dealing with the state of application of the aforementioned techniques in different countries.

The paper “The comparison of the multivariate techniques applied in the EDXRF provenance

study of the archaeological ceramic”, with the first results of the pottery analyses within THE FLOW project, was presented at the *International European Conference on X-Ray Spectrometry - EXRS2022*, held between the 27th of June and the 1st of July in Brugges, Belgium.² The goal of the paper was to determine the best approach for dealing with a large number of pottery samples and to suggest the most efficient method for the processing of the acquired analytical results. The 8th *Balkan Symposium on Archaeometry*, held in Belgrade between the 3rd and the 6th of October 2022, hosted a special event for the presentation of multidisciplinary projects financed by the Science Fund of the Republic of Serbia. The conference itself has significant importance for the territory of the Balkans and, therefore, the organisers created a special event in order to present examples of good practice in local science. Conference visitors were introduced to project goals and expected results. Within the same conference, the team of THE FLOW project presented the results of pigment analyses under the title “Preliminary investigation of the cinnabar origin and use on archaeological finds from an Early Metal Age site in north-western Serbia” (Gajić-Kvaščev *et al.* 2022).

At *TECHNART 2023 – An International Conference on Analytical Techniques in Art and Cultural Heritage*, held in Lisbon between the 7th and the 12th of May 2023, a paper titled “The newest metal findings from the Early Eneolithic house in South-eastern Serbia” was presented (Gajić-Kvaščev, Andrić and Bulatović 2023).

In the course of August 2023, several team members participated at the 29th *EAA Annual Meeting*, which was held in Belfast, Northern Ireland (**Figure 7**). The project presented the results of provenance analyses of four selected Early Eneolithic vessels from the site of Velika Humska Čuka, within a session that was focused on local production and local resources during prehistory (Mladenović *et al.* 2023). The lavishly decorated vessels, all typologically different, originate from an Early Eneolithic house dated to the mid-5th millennium BCE. The elemental composition of the vessels was compared with samples from three clay-pits in the vicinity of the site. The elemental

² More on conference: University of Antwerp 2022.



Figure 7. THE FLOW at the 29th European Association of Archaeologists meeting in Belfast, Northern Ireland (photo from the archive of the project).

composition of both the vessels and the clay pits was determined using an EDXRF spectrometer and the level of elemental similarity between the pots and the clay samples was quantified by hierarchical cluster analyses (HCA). The results have indicated that the vessels originated from one of the clay pits (clay sample No. 1), and that the vessels were made on-site using locally available raw materials.

Within the last year, members of THE FLOW project have published two articles: in one international journal and one high-ranking national journal, which partially or wholly represent the results of the project. The first article “Paulje, mound XI (mound K): new absolute dates and provenience of the earliest amber finds in Serbia”, was published in the *Contributions of the Institute of Archaeology in Zagreb*, Vol. 40/1, by the PI of the project and leader of WP 2, with experts from Poland, USA and Serbia (Cwaliński *et al.* 2023). The paper deals with the latest spectrometric analyses that indicate the origin of ancient amber (**Figure 8**) (Cwaliński *et al.* 2023: 88, fig. 6) found within the richest Late Bronze Age grave in Serbia (Paulje necropolis near Loznica). Besides the interest-

ing results and extensive discussion on trade, contacts, and origin of certain objects recorded at the necropolis, the paper provided the foundation for new scientific contacts with experts from the Institute of Archaeology, the University of Gdańsk in Poland, and the reputable Vassar College in USA. The Institute of Archaeology in Belgrade had no previous collaboration with the aforementioned institutions. The second article “The FLOW project – a contribution to the study of the cultural transmission of the Central Balkan communities and the neighbouring regions in later prehistory”, was published in a high-ranking national journal, *Archaeology and Science*, Vol. 18 (Bulatović *et al.* 2022). The paper presents the research ideas behind the project, as well as the basic theoretical and methodological perspectives of the research, which include a multidisciplinary approach based on analytical techniques of the natural sciences, such as physics and chemistry. The final goals of the project are to precisely determine the origin of samples and raw materials, create a spatio-temporal model with new absolute dates, and create a specific SQL database, in order to properly interpret the long-distance connections and population



Figure 8. The analysed amber from the central grave of Mound K at the Paulje necropolis (after: Палавестра и Крстић 2006).

networks in the Central Balkans during the Copper and Bronze Age.

During the final quarter of the first year of the project, team members submitted a paper to the *international journal Starinar* (M23). The paper titled: “Set of bronze jewellery from the site of Velika Humska Čuka near Niš, SE Serbia. A contribution to the study of interactions between Bronze Age communities of Central Europe and the Central Balkans” deals with a specific set of bronze finds that were discovered at the site of Velika Humska Čuka near Niš during the 2022 excavation campaign (Bulatović *et al.* 2023: in print). Aside from the results of the elemental analyses that were conducted at the Vinča Institute and presented in this paper, the paper also highlights the importance of long-distance connections in the transformation of Bronze Age communities in the Central Balkans.

CONCLUSION

Midway through the project, the team was able to observe that the research is progressing in the correct direction. Already, the preliminary results are in line with the presumption of the importance of long-distance connections in the transformation of Bronze Age communities in the Central Balkans. Confirmations have been found in the

new absolute dates and results of provenience analyses of the earliest amber finds in Serbia, as well as the origin of the newly found bronze sword. Additionally, the significance of local raw materials and traditions in manufacture has been recognised thanks to the analyses of jewellery and pottery samples.

The upcoming project activities will aim to consolidate the already established methodological procedures and, most importantly, to interpret the awaited outcomes and to integrate them into explanatory models of complex processes in societies in the later prehistory.

ACKNOWLEDGEMENTS

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REZIME

NA POLA PUTA PROJEKTA THE FLOW – METODE, PRAKSE I PRVI REZULTATI

KLJUČNE REČI: KERAMIKA, BAKAR, BRONZA, OPSIDIJAN, POREKLO SIROVINA, IZOTOPSKE ANALIZE, APSOLUTNO DATOVANJE.

U radu su sumirani rezultati postignuti tokom prvih osamnaest meseci trajanja projekta THE FLOW (*Interactions-Transmission-Transformation: Long-distance Connections in Copper and Bronze Age of Central Balkans*), koji zajednički realizuju Arheološki institute Beograd, Institut

za nuklearne nauke „Vinča“ i Filozofski fakultet Univerziteta u Beogradu.

Projektni tim je posetio dvanaest muzeja na teritoriji Centralne Srbije, prešavši više od 5.000 km. Sakupljeno je više od 400 uzoraka keramike sa 67 arheoloških lokaliteta za analizu provenijencije, termoluminiscenciju i optički stimulisanu luminiscenciju. Prikupljeni su i uzorci više od 64 bakarna i 150 bronzanih artefakata, kao i više od 25 uzoraka iz pozajmišta gline i rudnih ležišta. Ukupno je prikupljeno 30 uzoraka predmeta od opsidijana. Nakon prikupljanja uzoraka, sprovedene su procedure nabavke usluga za AMS i TL/OSL datovanje. Započete su i procedure za izvođenje izotopskih analiza u svrhu dobijanja informacija o poreklu bakra i kalaja. Ugovori za TL/OSL analize su potpisani sa Univerzitetskim institutom geologije „Isidro Parga Pondal“ iz La Korunje (Španija), a rad na AMS analizama je ugovoren sa laboratorijom „Isotoptech Zrt.“ iz Debrecina (Mađarska) i Rutgers Univerzitetom u Nju Džersiju (SAD).

Nakon instaliranja prenosnog XRD aparata i obavljanja prateće obuke, tim Instituta za nuklearne nauke „Vinča“ je pristupio primeni opreme. Razvoj analitičkih postupaka praćen je izradom *Priručnika za prenosni XRD spektrometar*. Tokom 2022. godine je timu bila omogućena i međunarodna obuka u primeni nedestruktivnih radiografskih metoda na kulturnom nasleđu (*Regional Training Course on Radiography for Cultural Heritage Preservation*) u La Valeti (Malta).

Laboratorijska istraživanja u okviru projekta su do sada donela mnoge važne rezultate, među kojima su oni o poreklu sirovina za izradu analiziranih keramičkih posuda, kao i pigmenata upotrebljivanih za njihovu dekoraciju. Dobijeni su i izuzetno značajni podaci o sastavu analiziranih predmeta od metala – oružja i nakita, na osnovu kojih su doneti preliminarni zaključci o tehnologiji njihove izrade, odnosno pripadnosti određenom regionu ili radionici. Buduće projektne aktivnosti biće usmerene ka konsolidaciji već uspostavljenih metodoloških postupaka, kao i interpretaciji rezultata i njihovoj integraciji u modele kojima se objašnjavaju složeni procesi u društvima u mlađoj praistoriji.

Članovi projektnog tima su tokom dosadašnjeg trajanja projekta objavili dva rada u visoko rangiranim međunarodnim časopisima. Projekat i njegovi dosadašnji rezultati predstavljeni su na 65.


Međunarodnom sajmu tehnike i tehničkih dostignuća u Beogradu, *XLVI godišnjem skupu Srpskog arheološkog društva* u Somboru i godišnjem skupu Arheološkog instituta u Viminacijumu, svi u 2023. godini, kao i na više međunarodnih naučnih skupova: u Dojranu (Severna Makedonija), Brižu (Belgija), Lisabonu (Portugal), Belfastu (Severna Irska) i Beogradu, tokom 2022. i 2023. godine. Takođe, projekat THE FLOW je tokom svojih aktivnosti inicirao stvaranje mreže naučne saradnje između više institucija, što se može nastaviti kroz buduće zajedničke projekte.

* * *

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DIGITAL TOOLS – A NEW ERA IN ARCHAEOLOGY

ABSTRACT

The use of digital technology and digital tools in the research, preservation, and presentation of archaeological heritage is crucial these days. In order to manage resources efficiently, good planning and strategy are necessary. Additionally, in order to plan well, it is necessary to collect, classify, process, and store data. Archaeology, as a science, requires meticulous work on data collection, processing, storage, interpretation, and presentation. A question that is increasingly becoming the focus of all interested parties is the relationship between archaeology and other sciences in terms of exchanging data. The relationship between field archaeology, scientific research, economy, economic development, and spatial and urban planning is mentioned in many works. The main aim of this paper is to promote the need to unify the archaeological documentation used by all interested parties in archaeology, culture, and spatial planning in Serbia and to connect all participants in this process through an information system. Special attention will be paid to the relationship between archaeology, GIS, and spatial planning. An exceptional example of the use of digital tools in archaeology is a map of archaeological sites, which can play a vital role in the coordination of activities in this field.

KEYWORDS: DIGITAL TECHNOLOGY, APPLICATIONS, GIS, DATA, ARCHAEOLOGICAL MAPS, SPATIAL PLANNING.

INTRODUCTION: DIGITISATION OF ARCHAEOLOGICAL DATA IN SERBIA

It is noticeable that in Serbia, a lot of time and effort has been invested in developing a centralised information system for cultural heritage. This includes the digitisation of relevant documents and multimedia data about diverse cultural heritage objects, including archaeological sites, their excavations, and intricate documentation, among others (Kazi *et al.* 2021: 4). Some of the earliest projects in this area in Serbia were carried

out in the 1990s, with the PANDORA expert system being the first one in digitisation of archaeological heritage (Mijajlović and Ognjanović 2004: 53; Korać, Ognjanović i Dugandžić 2006).

Of great importance in defining the framework for the use of digital tools in archaeology is the need for a governed process of digitalisation with clear guidelines to cultural institutions on how to preserve digital and digitised heritage and make it available “at the click of a button” (Ognjanović *et al.* 2019: 1). The *Rulebook on the forms, content, and manner of keeping work logs and other documentation that is kept on archaeological excavations and research* (Правилник 2020) gives the

prescription that archaeological documentation should be preserved electronically, using a unique information system, with an aim to “incorporate data and information accessibility for institutions of protection and other state institutions” (*Rulebook on detailed conditions for the digitalization of cultural heritage* (Правилник 2018) (Tapavički-Ilić and Šegan-Radonjić 2021b: 206)). The metadata scheme, as adopted in the previous rulebook (Правилник 2018), needs to be implemented in the information system for cultural heritage documentation management. This process ensures the preservation, presentation, and accessibility of archaeological sites (Ognjanović *et al.* 2019: 1). Information about archaeological sites transmitted using modern digital technologies makes a great contribution to the development of an inclusive society since it has a positive effect on a large number of users, among which are members of the PWD (persons with disabilities) community (Масликовић и Томић 2015).

The same rulebook (Правилник 2018) regulated that all cultural institutions must use information systems. This opened the door to implementing information systems in these institutions and enabling potential connections, networking, the creation of large databases, and data sharing.

INFORMATION SYSTEMS IN SERBIA CONNECTED TO ARCHAEOLOGY

During the last three decades in Serbia, there have been attempts at the creation of various information systems connected to archaeology, such as the Information System for Archaeology (ISA) (1989), the Proposal for the application AGORA BBS (1991), the Archaeological database model proposal (1994), Proposal for the application SUPERBASE for Archaeologists (1999), etc. “However, due to the lack of funding for the equipment, coordinating mechanisms and the lack of experts, as well as the fast development of technology, the suggested solutions were either not accepted or did not last very long” (Šegan-Radonjić, Tapavički-Ilić 2021). ArcheoPackPro! is an information system designed for the entry, processing, and interpretation of digitised archaeological documents (Tasić i Jevremović 2001: 54; Tasić i Jevremović 2003). It was created over the course of six years

of fieldwork and used during the excavation of the archaeological site of Vinča, with the aim of enabling archaeological teams to immediately enter and process data collected in the field. This software package was intended for use in two separate processes of archaeological research: field processing and the input of data into documentation; and the processing, analysis, and interpretation of the excavated material (Tasić i Jevremović 2001: 54–55).

Some information systems connected to archaeology currently existing in Serbia are:

- ISNKD - Information system of the immovable cultural property, a web portal run by the Republic Institute for the Protection of Cultural Monuments (ИЧКД);
- GeoSrbija - national GIS web platform, a web-based interactive map with embedded cultural heritage properties, run by the Republic Geodetic Authority (ГеоСрбија) (**Figure 1**);
- IMUS - Unique Information System, application for the museum information system of Serbia, implemented in 78 museums, run by the Historical Museum of Serbia;
- ARHIMUS - a separate piece of software for the digitisation of archaeological field documentation, which works as part of the IMUS owned by the Museum of Vojvodina;
- The Cultural Heritage Browser of Serbia - the first unified browser for cultural heritage search and mapping of monuments and cultural institutions of the Republic of Serbia, initiated by the Ministry of Culture (under redesign).

ARHIMUS

The ARHIMUS software, created in 2017, can be accessed through IMUS. It is a project devoted to the digitisation of archaeological field documentation and is used by the archaeologists in the Museum of Vojvodina. ARHIMUS has not been adopted as official software, although no information system has been declared official in archaeology. It is still in its development phase, with the

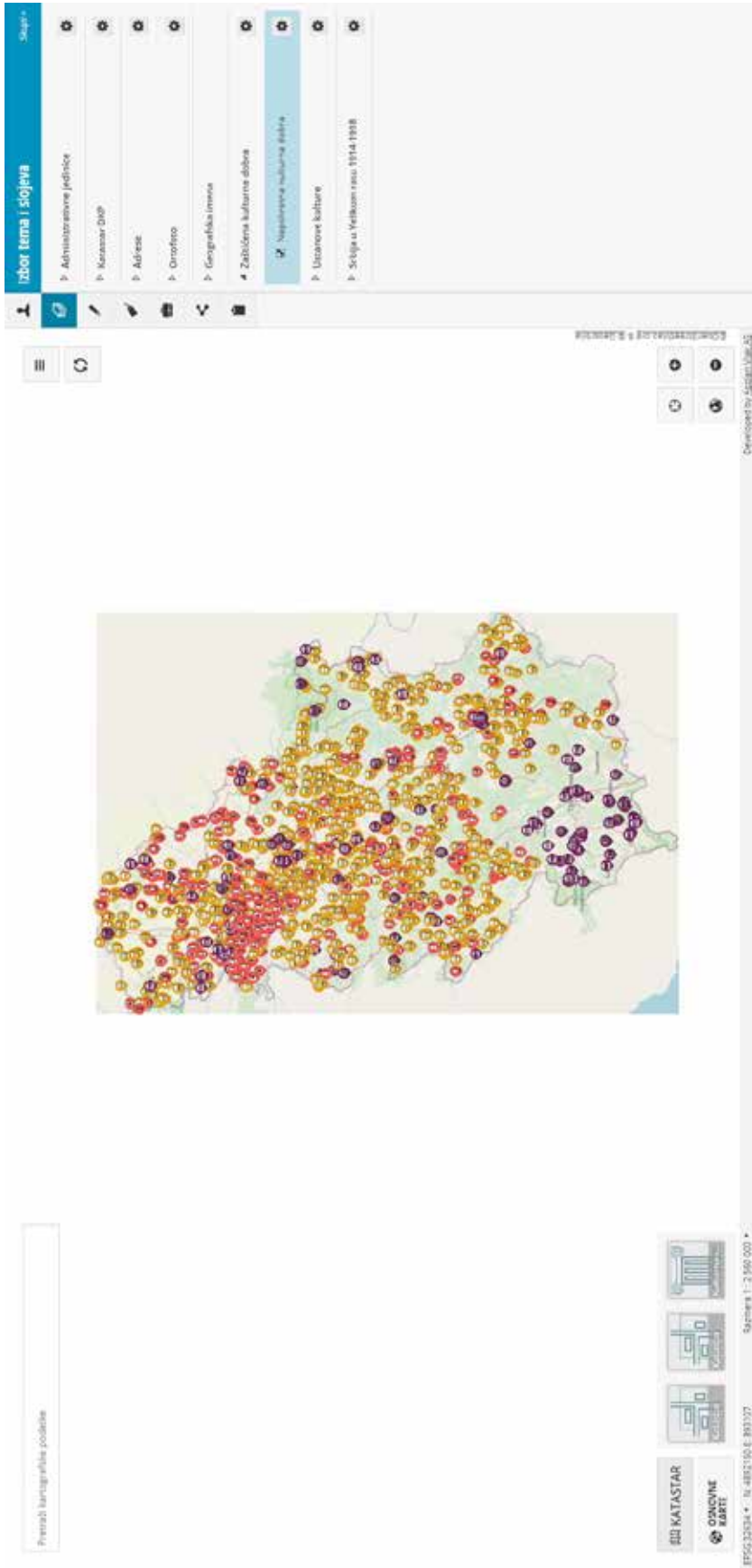


Figure 1. Screenshot of the display of the layer with the locations of the immovable cultural properties, as shown in the web-based interactive map run by the Republic Geodetic Authority (GeoCpđija).

aim to correlate it properly to the *Rulebook on the forms, content, and manner of keeping work logs and other documentation that is kept on archaeological excavations and research* (Правилник 2020). By incorporating the ARHIMUS application as a module of the IMUS for museums, it is possible to exchange data from all participants in the protection of cultural heritage – archaeologists, curators, and conservators – in the same information system. It also offers an opportunity to link archaeological field documentation with the main museum inventories, enabling curator-archaeologists to select the most important artifacts of field inventory and immediately include them in the main museum inventory. In such a manner, the processing of museum documentation is faster and easier. Regarding archaeological field documentation, ARHIMUS includes field diaries, levelling diaries, photo diaries with digital photos (**Figure 2**), field inventories and C-cartons with drawings and photos, technical documentation (photogrammetry and drawings of researched objects), and archaeozoological, archaeobotanical, and anthropological (**Figure 3**) reports. In this way, once entered, data becomes available in several ways, which contributes to faster, more efficient, and simpler processing of documentation.

The ARHIMUS creators aimed to reduce the processing time of the entire documentation on archaeological objects (field and main inventory), as well as to simplify the process, leaving experts more time for scientific research work and the interpretation of the past. The plan is to develop a mechanism and measure the performance of the ARHIMUS system as well as the performance of other information systems that are in use in archaeology. All information regarding an archaeological object, from the moment it was found in the field to the moment it became a part of the museum collection, is available in one place.

CONNECTIONS BETWEEN ARCHAEOLOGY, SPATIAL PLANNING AND GIS

Spatial planning is an instrument of public policy. It considers the interaction among policy sectors according to different territorial units; national, regional, and local, across a wide range of policy sectors. It addresses different kinds of

problems; economic, social, and environmental, as well as the strengthening of social cohesion and using all possibilities offered by the processes of globalisation and technological innovations. The scope of spatial planning differs greatly from one country to another. However, in nearly all countries spatial planning systems encompass some fundamental functions: spatial planning provides a long or medium-term strategy for territories in pursuit of common objectives, incorporating different perspectives of sectoral policies; spatial planning deals with land use and physical development as a distinct sector of government activity alongside transport, agriculture, environment, etc.; spatial planning can also mean the planning of sectoral policies according to different spatial scales (Đorđević and Dabović 2004: 84).

Administratively, spatial planning is practiced at different levels of government: national, regional, municipal or local. At the local or municipal level, spatial planning, in many cases, centres on land use planning in order to regulate land and property uses (Đorđević and Dabović 2004: 84-85). On the basis of spatial planning, local administrations prepare documents such as detailed spatial regulation plans, which enable the development of industrial zones, free trade zones, duty-free zones, and infrastructure (roads, energy, telecommunications, etc.). It provides good conditions for economic and social development in a regulated environment.

The sudden penetration of natural sciences into archaeology in the middle of the 20th century is the result of the so-called processual or new archaeology as a special and new direction in the theoretical and exact development of archaeology, but also a consequence of the need to adopt new methods that will facilitate the discovery of sites (Stanković Pešterac 2014: 219). Since the beginning of the 1960s, different geophysical methods have been used and adjusted to archaeological needs (Pešterac 2006: 53; Stanković Pešterac 2014: 227). Today, there is no need to speculate on the significance of the role of geosciences in archaeology (Stanković Pešterac 2014: 227). A large number of known sites and the discovery of new ones due to the emergence of new prospecting methods, especially geophysical, which non-invasively obtain precise images of what is hidden under the



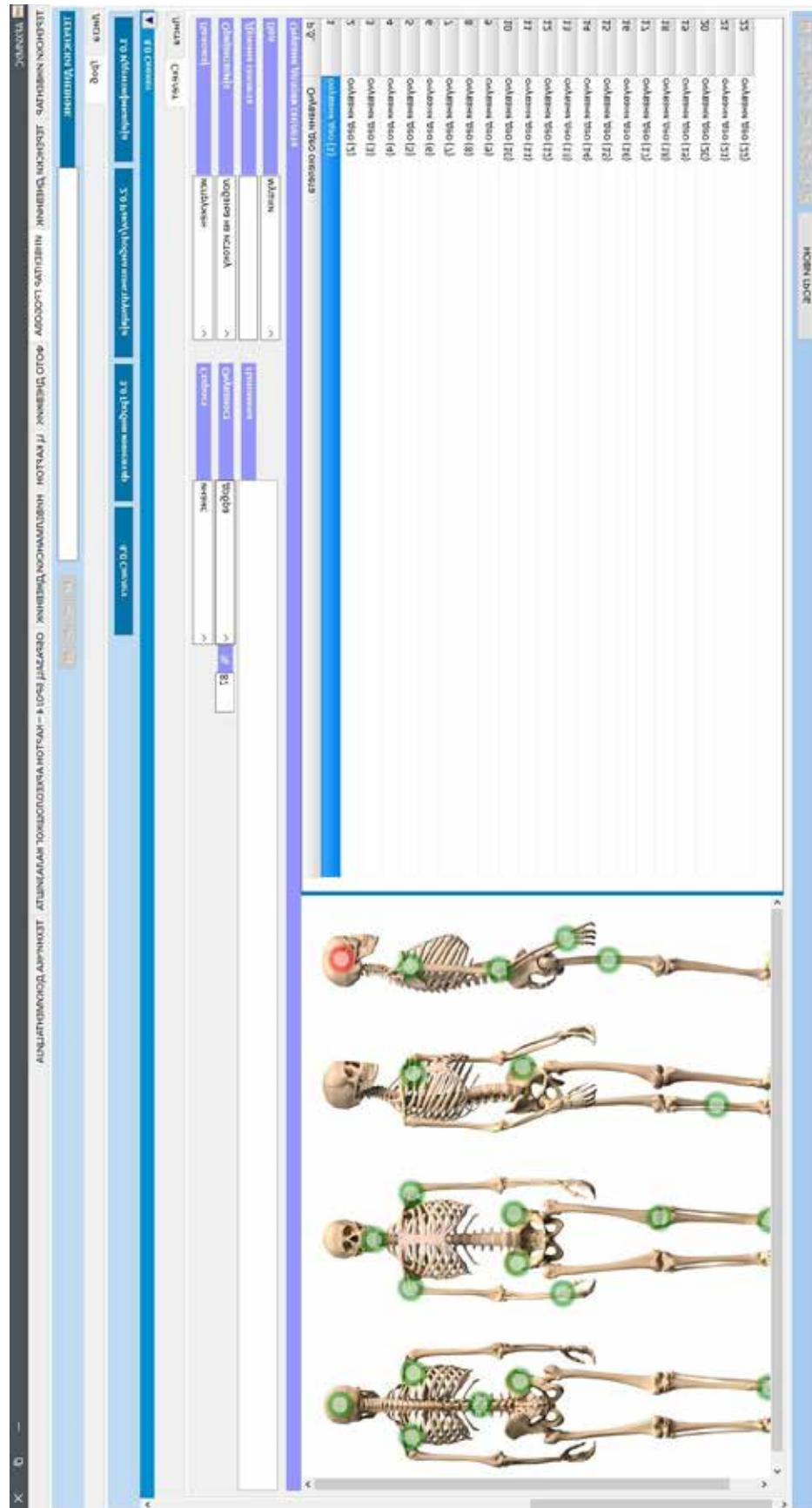


Figure 3. Screenshot from ARHIMUS with a segment for marking the found human skeletons with a description (accessed by authorised person Natalija Vulikić on June 22nd 2023).

earth's deposits, require serious documentation and data processing systems.

The use of GIS in the field of culture and heritage has grown significantly. The reason can be sought in the increase of multidisciplinary studies in this area that use the support of the natural sciences, including geographic information (García *et al.* 2022: 97). The term GIS is not a term that has recently appeared in archaeological studies. It has been present in papers and practice since the 1980s. Despite that, in practice, it was applied ten years later in Europe, in the early 1990s (Scianna and Villa 2011: 337). Since the mid-1990s, GIS has become more connected to other disciplines' work techniques and provided them with support. It was used in the processing and application of satellite images, and in the integration of geophysical survey data with spatial data (Novaković 2003: 155–167). Due to the availability of advanced performance information and communication technology and modern topographic instruments used in geodesy (total stations, GNSS receivers, laser scanners, etc.) that can collect georeferenced data on the area of archaeological excavations, GIS applications used in archaeology have evolved in parallel (Conolly and Lake 2006: 50–62).

GIS is used in archaeology because it collects data that matches the data needed by archaeologists and allows them adequate research analysis, spatial queries, statistical spatial analysis, different map layers, slope calculation, filtering and overlapping with layers of geology, natural disaster analysis, methods for regional analysis, visibility analysis, export of data for printing and production of publications, collection of metadata, etc. It is a precious source of practical information for archaeologists, whether in scientific research or in practical field work (Conolly and Lake 2006: 68). Therefore, Geographic Information Systems have an increasing role in archaeology, facilitating archaeological analysis and interpretation. This tool stands out as a mechanism for managing archaeological resources. It also plays an important role in the preparation of fieldwork, where advanced analyses are used both for control and model analysis of visibility and intervisibility, as well as GIS assisted three-dimensional modelling (Wheatley 2013: 78).

GIS is also important in the protection of ar-

chaeological heritage, particularly in systematic conservation planning (Malaperdas 2021: 1) since it is capable of managing large quantities of graphic and alphanumeric data (Scianna and Villa 2011: 342). The first step in GIS exploitation was to convert information from an analogue to a digital format in order to improve operations and procedures carried out by hand and it was also used as a tool to record and store information. The capability to record, manipulate, and analyse a large amount of diverse geographic and environmental variables appears to be of great interest, as well as the possibility of creating some predictive simulations based on settlement patterns. The integration of archaeological information in urban planning is one of the goals (Scianna and Villa 2011: 342).

Another aspect is the use of data for education. A good example can be found in the research that proposes the use of GIS for motivating students to gain new knowledge of space and the environment, making visual timelines of historical events, etc. (Maldonado López 2012: 42–43; García *et al.* 2022: 93).

We can conclude that GIS is essentially a “grouping of data, procedures, hardware, software, and human resources” (Santovenia Díaz, Tarragó Montalvo and Cañedo Andalia 2009, as referenced in García *et al.* 2022: 93) used to work with geographic data. Therefore, it is not just a database, but a complex tool that has advanced analysis, comparison, and simulation functions. Its use by professional archaeologists leads to faster and better results in archaeological research and enables the application of different methods and techniques when performing archaeological research (García *et al.* 2022: 93, 96).

Archaeological data has a dual nature. It is distributed both in space and time. “A characteristic common to all GIS software is the capacity to manage multi-layer and multi-scale georeferenced geographic data: this potential makes GIS applications ideal for managing archaeological data” (Scianna and Villa 2011: 337). Given that the nature of most archaeological data is very complex and contains a lot of information from the fields of natural sciences and spatial planning, GIS technology has emerged as the most flexible and complete system for analysing the spatial context of archaeological data (Scianna and Villa 2011: 337). Today, geographic information sys-

tems are very present in archaeological research and are increasingly used in the field of protection and management of cultural heritage and archaeological sites. Digital archaeological documentation of excavations as well as digital modelling are becoming integral parts of archaeology. With the development of GIS and the use of ICT in archaeology, new applications in the field of archaeology will appear (Marić 2011: 121).

The development of the National GIS Web platform in Serbia (ГеоСрбија) enables the display, search, analysis, transformation, creation, sharing, and maintenance of geospatial data, resulting in the harmonisation of procedures for obtaining construction permits, preparation of general and detailed urban plans, and communication between cultural institutions, researchers, and the economy. This can contribute to the protection of digitised cultural heritage objects, the long-term preservation of digitised cultural heritage, the creation of new material and additions to existing material, as well as the application of international standards in the process of site search, increasing accessibility to the general public, and data entry.

MAPPING OF ARCHAEOLOGICAL SITES

A good example of the use of digital tools in archaeology is the map of archaeological sites. The creation of the map in its digital form is deemed an urgent matter in Serbia due to its essential role in coordinating the field of archaeology. As far back as 1991, a project for the creation of an Archaeological Map of Serbia was initiated, as a part of the scientific and research work of the Serbian Academy of Arts and Sciences, with the Institute of Archaeology as the responsible institution. Buildings and artifacts in the map were “determined geographically, chronologically, historically and descriptively”, and the filled records were accompanied by the topographic maps (Бошковић 1991: 142). Unfortunately, the project was not concluded.

Based on the twenty-year experience and the insight into the documentation of different cultural institutions that deal with archaeological research that the authors of this article have had during their work, we can say that the overall percentage of archaeological sites in Serbia that have been

recorded is relatively small compared to their actual number. In some cases, there is no existing documentation for certain sites that have been researched, even though it is prescribed by different laws and rulebooks – the Law on Cultural Property (Закон 1994), the Law on Cultural Heritage (Закон 2021) and the *Rulebook on forms, content, and methods of keeping records of work and other documentation related to the archaeological excavations and research* (Правилник 2020).

Introducing an e-business leads to uniformity and transparency in the work of archaeologists and ultimately leads to visibility and accessibility of extremely rich archaeological heritage. This, in turn, results in a transparent record of archaeological sites, with an emphasis on the risks involved in record transparency, where analysis and statistics can be performed using various tools. Similar projects exist in other countries as well. The authors of this paper had the opportunity to become familiar with a very similar project in the Republic of Slovenia named *From Cloud to Landscape* (From Cloud to Landscape). Slovenia mapped all archaeological sites using Lidar images as the basis, together with other data from involved institutions and field research.

The objectives of the mapping of archaeological sites should be: keeping accurate records of archaeological sites; unification of archaeological field documentation on immovable and movable cultural assets; monitoring the protection of archaeological sites; determination of priorities for archaeological research according to the degree of threat and importance, which achieves efficiency in decision-making and control of spending when financing archaeological works (excavations, reconnaissance, prospecting and publishing); achieving uniformity and transparency in work; and support to the economy (spatial planning, urbanism and construction, environmental protection, tourism, etc.).

Significant attention should be paid to data protection. Not a single piece of information that could damage the integrity and security of the archaeological site should be made publicly available. The map should be an information system for storing unified documentation on archaeological excavations and locations with geo-positioning for the sites that have been declared cultural property and those that are under preliminary pro-

tection. The map needs to contain data about the existing and adopted plans (urban plans; development plans - such as industrial and infrastructure plans; etc.), for specific areas, which contain the measures for the protection of the cultural properties located in those areas, following the current legal regulations. These systems can also enable protection on multiple levels, especially since a cultural property cannot be considered a cultural property in the true sense of the word if proper documentation is not kept on it in a uniform manner (Bojković 2014: 38).

Mapping of archaeological sites should improve digital methods and techniques for the preservation, documentation, and research of the immovable cultural heritage and its presentation. The map should provide a systemic, quality, and uniform approach as well as a contribution to the national and international networking of digitised immovable cultural heritage. Nationally, state authorities should have the opportunity to analyse data, develop strategic plans, and obtain financial support by utilising databases. This would also strengthen the capacity of institutions and individuals and make cooperation between relevant national and regional communities more productive.

CONCLUSION

The cooperation of all interested parties, i.e., state bodies and public institutions, is necessary for the protection and preservation of cultural heritage in any country. The strengthening of heritage protection should be carried out with a special focus on spatial planning optimisation, strengthening the capacity of institutions and individuals to perform the digitalisation process, making a database of all archaeological sites, combating the illicit trafficking of cultural property from, through, and in the region, and promoting its restitution to the country of origin.

Data centralisation is required, considering the presentation of the current situation of the archaeological information systems in Serbia. However, the advancement of centralised and unified data collection and record-keeping on archaeological findings is not possible without unique software for document management. The creation and use of the map of archaeological sites can introduce order into the documentation of archaeological

sites and data obtained through different archaeological research (excavation or reconnaissance, that is, prospecting), which indirectly protects this important part of the cultural heritage. It can promote strategic thinking in the preservation of archaeological sites, continuous scientific research work, as well as unhindered economic development in Serbia.

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REZIME

DIGITALNI ALATI – NOVA ERA ARHEOLOGIJE

KLJUČNE REČI: DIGITALNA TEHNOLOGIJA, APLIKACIJE, GIS, PODACI, ARHEOLOŠKE KARTE, PROSTORNO PLANIRANJE.

Upotreba digitalne tehnologije i digitalnih alata u proučavanju, očuvanju i prezentaciji arheološkog nasleđa ključna je u današnje vreme. Da bi se efikasno upravljalo resursima, neophodni su dobro planiranje i strategija, a da bi se dobro planiralo, potrebno je prikupljati, klasifikovati, obraditi i čuvati podatke. Arheologija, kao nauka, zahteva pedantan rad na prikupljanju, obradi, čuvanju i prezentaciji podataka. Pitanje koje je sve više u fokusu svih zainteresovanih strana jeste odnos

arheologije i drugih nauka u pogledu razmene podataka. Odnos arheologije, naučnih istraživanja, privrede, privrednog razvoja, prostornog i urbanističkog planiranja, pominje se u mnogim pisanim radovima. Izuzetan primer upotrebe digitalnih alata u arheologiji Srbije može biti mapa, odnosno karta arheoloških lokaliteta, od suštinske uloge u koordinaciji aktivnosti u oblasti arheologije.

* * *

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INFORMATION SYSTEM OF IMMOVABLE CULTURAL PROPERTY AS AN INSTRUMENT FOR THE PRESENTATION OF THE ARCHAEOLOGICAL HERITAGE OF SERBIA

ABSTRACT

The Information System of Immovable Cultural Property (IS NKD) is one of the five basic information systems for the digitization of the cultural heritage of the Republic of Serbia. In the framework of this information system, data on the protected immovable cultural heritage of the Republic of Serbia (immovable cultural property) is stored. The IS NKD contains data on the legal protection of property, other obligatory documentation that legally must accompany any protected site or object, as well as auxiliary documentation related to the history, values, features, condition or undertaken conservations, restorations and other works of cultural property. One type of immovable cultural property are archaeological sites, but archaeological localities may also be one of the remaining four types of immovable cultural property, or part of them. Within the IS NKD there is a special space provided for the entry of data on carried out archaeological research concerning a specific site or object. The presentation of existing information on the archaeological heritage of the Republic of Serbia is not intended solely for experts from the cultural heritage protection service. One of the goals of the IS NKD is to make cultural heritage more familiar and more accessible to the broader public.

KEYWORDS: IMMOVABLE CULTURAL PROPERTY, ARCHEOLOGICAL SITE, DIGITIZATION, INFORMATION SYSTEM OF IMMOVABLE CULTURAL PROPERTY.

INTRODUCTION

Digitization of documentation and information of the immovable cultural heritage of the Republic of Serbia is carried out for three reasons. The first is the long-term retention of documentation and information about immovable cultural heritage (which is, at the same time, a form of backup of them). The second is to facilitate the work of employees in all institutes for the protection of cultural monuments (some information will now be “just a few clicks away”). The third, but no less important than previous two, is to allow a greater

visibility of cultural heritage to the public.

The *Information system of Immovable Cultural Property* (Serbian: *Informacioni sistem nepokretnih kulturnih dobara*, abbreviated: IS NKD) is one of the five basic information systems for the digitization of the cultural heritage of the Republic of Serbia.¹ The IS NKD was created in 2016, and has been continuously upgraded since. It was

¹ The other four obligatory systems are for movable cultural heritage, which is kept in museums (IMUS), the archives (ARHIS), libraries and the National Film Archive of Republic Serbia in Jugoslovenska Kinoteka (Правилник 2018:, Article 3).

developed in cooperation with the Institute for the Protection of Cultural Monuments of Serbia (who prepared the project tasks and goals) and Mega Computer Engineering of Belgrade (who designed the software).² During the process of creation, conversations were conducted with other institutes for the protection of cultural monuments in Serbia, in an attempt to gather their previous experiences on similar tasks. The creation, development and maintenance of the IS NKD are all financed by the Ministry of culture (and information) of the Republic of Serbia (Лажбеншпергер 2018: 30). It is designated by the Ministry of Culture as the main information system used by institutes for the protection of immovable cultural heritage in Serbia (*Rulebook on detailed conditions for the digitization of cultural heritage*) (Правилник 2018, Article 3, paragraph 1, point 2). All institutes for the protection of cultural monuments from the territory of the Republic of Serbia participated in populating the IS NKD with data regarding immovable cultural assets.

A number of cultural and scientific institutions, faculties and enthusiasts have tried to create some kind of information system of immovable cultural properties in Serbia. However, some of the previously developed systems are not fully functional today. In some of them the data entry has not been completed, some systems do not exist anymore, or are only used internally by a single organisation (Ognjanović *et al.* 2019: 2-4, 8-9; Šegan-Radonjić and Tepavički-Ilić 2020: 208-218). Among them, probably the most important is the system called *Cultural Monuments of Serbia* (Serbian: *Споменици културе у Србији*). Detailed information about all the former systems does not exist. For some of them we only have information that the systems were prepared, but the results themselves cannot be seen. Often, we cannot be sure if they were really a system, or if they were closer to some form of database. As a result, any attempt to adequately represent all these previous efforts within this work would be unsuccessful. For the stated reasons, this paper aims to review the IS NKD, as a system that is currently successfully used in their work by institutions for the protection of cultural monuments in Serbia.

² The first author of this paper is the main creator of IS NKD, while the second author has been working on it for a couple of years.

WHAT IS THE IS NKD?

The IS NKD is a software for digitization, a web-based application that can only be accessed via the internet. It has two separate parts. One for the employees in the service for the protection of immovable cultural properties, and another for the public. The two separate parts are made for better protection of the stored information. The public part has less information, but includes all basic and necessary data for an elemental introduction to some cultural property. The public part of the IS NKD can be accessed via the following address: nasledje.gov.rs. An English version of the public part of the IS NKD is also available, but not all of the descriptions have been translated yet.

The basic idea for making the IS NKD web based and not a desktop application was the requirement for information about immovable cultural properties to be available to experts from institutes for the protection of cultural monuments in any location from where they can access the internet, and not only in their offices. This also allows information to be transferred quicker to other governmental institutions and to the owners and users of the cultural heritage.³

WHAT DOES THE IS NKD INCLUDE?

Digitization of data in the IS NKD is carried out for documentation and information defined as obligatory according to *Law on Cultural Property* (Закон 1994: Article 79, paragraph 2, point 5),⁴

³ The process of creation of any publicly available database of archaeological sites is a very sensitive task. Namely, there can be many possible human threats to non-excavated, not well-known archaeological sites, or those in remote areas, especially by making data on their exact position available to everyone. However, these problems are not the consequence of the availability of the information in the database itself. This paper's description of the IS NKD points to the great advantages that come from gathering so much information on the sites in one place, and notes the attempts by its creators to ensure its secure use. However, the further discussion on these topics is not the aim of this paper.

⁴ The development of the IS NKD started while the article 79 from the Law on Cultural Property was in force, and continued on the basis of the article 74 from the Law on Cultural Heritage.

Law on Cultural Heritage (Закон 2021: Article 74, paragraph 1, points 15 and 16) and *Rules on the Data that are entered into the register, method of keeping the register and central register of immovable cultural property and on documents related to such cultural property* (Правилник 1995). Besides the aforementioned, other documentation is also added.

According to the *Law on Cultural Heritage* (Закон 2021: Articles 15 to 19), there are five types of cultural property - monument of culture, archaeological site, significant site, spatial cultural-historical area, and cultural landscape. An archaeological site is defined as a part of the space on the surface of the soil and in the ground, in caves and under water, that contains the remains of individual buildings, complex building entities and other artefacts, constructions and their parts, burial units and necropolises, hoards, movable artefact, anthropological, paleontological and geological material, as well as the entire stratigraphic context in which they are found (Закон 2021: Article 18). Some archaeological localities are inscribed in the Central Register of immovable cultural properties as a monument of culture. That is usually the case for fortresses from the Middle Ages and modern periods (for example: Maglič medieval town, Zemun Fortress, or Niš Fortress). However, there are also a number of other archaeological localities inscribed as this type, such as several Roman tombs (for example: Late Roman tomb in Brestovik), or remains of churches (for example: Church of Mrnja, in Bačevica near Knić), etc. Besides that, archaeological remains can be incorporated into three other categories - significant site, spatial cultural-historical area, and cultural landscape. Among these three types, we may mention one more spatial cultural-historical area that is, in most of its characteristics, a fortress, but also has other values. It is the Petrovaradin Upper and Lower Fortress and its suburb. Many immovable cultural properties become archaeological localities when there is a need for archaeological research of them or their surroundings.

Currently (June 2023), 2,635 immovable cultural properties have been determined. Of that number, the Central Register and the IS NKD contain information on 196 archaeological sites and slightly more than 60 archaeological localities that are included in another type of immov-

able cultural heritage. It is difficult to determine exactly how many archaeological sites are part of the areas that are protected due to other values, but it is certainly a large percentage of the total number of those areas.

The information on archaeological sites held in the IS NKD is the same as the information for the other four types of immovable cultural heritage. Besides the name of property, and its type, there are these main pieces of information: its location (region, municipality/city, place (town or village), street, street number and GPS coordinates), name of the institutes that have jurisdiction for the protection, number and date of entry in the register, number and date of the entry in Central Register, Decision on the recognition of the immovable cultural property, number and date of the Official Gazette of the Decision of the recognition, category,⁵ number and date of the Official Gazette of the Decision of the categorisation, numbers of cadastral parcels of immovable cultural property and its protected zone, measures related to guarding, maintaining and use of cultural property and its protected zone and a short description of the immovable cultural property. Also, the following scanned documents are included: Decision on the recognition of the immovable cultural property, Official Gazette of the Decision of the categorisation, copy of the cadastral plan, excerpt from the land register, public announcement of the intention to protect the object or site, Act that a note in the land register was made, photo documentation (general appearance and appearance of characteristic details) and technical documentation (situation, the basis of the object, cross sections of the object and appearance of characteristic details). There are some other files that offer more information about certain properties and their conservation and protection (**Figure 1**).

Besides the aforementioned, other information is also included. Such as: date or period of origin, proposal for the recognition, reports on the condition of the object or site, measures of technical protection, information about the UNESCO World Heritage List (if cultural property is on it), information about nature protection (if cultural


⁵ Which can be: Immoveable Cultural Property, Immoveable Cultural Property of Great Importance or Immoveable Cultural Property of Exceptional Importance.

ИЗМЕНИ СПОМЕНИК

Име у Регистру:

Назив НКД: Други назив НКД:

Врста непокретног културног добра: Део другог НКД:

Главна слика: 

Унес у централни регистар


Рачни број у централном регистру: Број у централном регистру: Датум уписа у централни регистар: Број досијеа у централном регистру:

Округ: Општина/Град: Место: Адреса:

Град Београд	Савски Венац	Београд	<input type="button" value="Унеси"/> <input type="button" value="Очисти"/>
Град Београд	Врачар	Београд	<input type="button" value="Унеси"/> <input type="button" value="Очисти"/>
Град Београд	Палилула	Београд	<input type="button" value="Унеси"/> <input type="button" value="Очисти"/>
Град Београд	Земун	Београд	<input type="button" value="Унеси"/> <input type="button" value="Очисти"/>
Град Београд	Стари Град	Београд	<input type="button" value="Унеси"/> <input type="button" value="Очисти"/>

Некадашња адреса, са хронологијом промена

ГПС координате



Основа за унос у регистар / Одлука о утврђивању:

Број и датум службеног гласила Одлуке о утврђивању:

Одлука о утврђивању:

Историјат Завода за заштиту споменика културе града Београда бр. 176-6 од 30.6.1964. о утврђивању својства променливе културне АНШЕА
Beogradum.pdf

Категорија:

Напомена о категоризацији:

Број и датум службеног гласила одлуке о категоризацији:

Одлука о категоризацији:

Налази се на листи светске културне и природне баштине УНЕСКО

☐ Да ☒ Не

Figure 1. Appearance of part of the page of one immovable cultural property in the IS NKD (the page was accessed by the author of the paper, as the authorised person) (accessed on November 27th 2023).

property is part of it), literature, multimedia, additional descriptions, other photo and technical documentation, etc. There is also a special section just for documentation from archaeological excavations. However, it is not intended only for archaeological sites. As there are archaeological locations in other types of immovable cultural properties, and each immovable cultural property can become a site where archaeological research can be carried out, or archaeological remains can be found, this section exists in every immovable cultural property in the IS NKD. It is predicted that this documentation is inserted by archaeological campaigns. Information in text form that is included in this section includes: name of the institution that is the job holder; name of the field conductor; year of excavation; number of the Decision of the competent authority that issues the excavation permit; and the source of finance. The predicted scanned documents are: excavation report; field excavation diary; levels measurement register; photo diary and photo sheets; inventory of finds; special finds; drawings, plans, situations; documentation of conservation of finds; and a file for other documentation (anything that is not covered within the previously mentioned fields).

The part for the public contains: name of cultural property; its location [municipality/city, place, street and street number, and a map with the location marked]; name of institute that has territorial jurisdiction for the protection; name of institute that has jurisdiction for issuing technical protection measures; number and date of entry in the register; number and date of the entry in Central Register; Decision on the recognition of the immovable cultural property, number and date of the Official Gazette of the Decision of the recognition; PDF of Decision on the recognition of the immovable cultural property; category; number and date of the Official Gazette of the Decision of the categorisation; PDF of Decision of the categorisation; information about the UNESCO World Heritage List; description of cultural property; literature; and multimedia and photo documentation (**Figure 2**).

Part of the data in the IS NKD is entered in text fields, and part is uploaded as scanned documentation that was created on paper or documentation that has already been created in digital form, so it only requires transfer to the system.

Scanned documentation is created and stored in PDF format. Documentation that has previously been created digitally is in the format in which it was created or transferred to PDF, JPG or some other format specified by the *Guidelines for digitization of cultural heritage of the Republic of Serbia* (Смернице 2017, part 6.1), depending on the need and case.

On the first page of the IS NKD is a map of Serbia with the locations of immovable cultural properties (**Figure 3**). For all five types of immovable cultural property there are different labels (rectangle - archaeological site; rhombus - monument of culture; triangle - significant site; circle - spatial cultural-historical area and hexagon - cultural landscape). The category of immovable cultural property is marked with three different colours (red - immovable cultural property of exceptional importance; blue immovable cultural property of great importance; yellow - immovable cultural property). Clicking on one of the labels, visitors can obtain information about the name of the object/landscape, along with its type and category. From that information they can proceed to additional information about that cultural property. Also, they may use other tools that are available on Google maps, such as directions or street view. A detailed search is available for the desired object or locality in the IS NKD. They can be searched for based on one or more terms, or just on a part of a term. Searches can be conducted by the name of immovable cultural property, as well as by location, type, category, territorial jurisdiction, etc. (**Figure 4**).


Part of the IS NKD for Property under Preliminary Protection has also been developed. However, the input of data has not started yet, since the initial emphasis has been on compiling data for immovable cultural properties. It is expected that the upload of data into these parts of the IS NKD will start soon. Among the Property under Preliminary Protection are many archaeological localities (Закон 2021: Articles 29-35).

IMPORTANCE OF IS NKD

The IS NKD is an important tool for the work of the service for the protection of immovable cultural properties. Through it, one can access all the important information that exists about a

Градина код Новог Раковца

[Штампај](#)



Назив: Градина код Новог Раковца

Општина: Беоцин

Место: Раковац

Адреса: улица Светосавска

Надлежност: Покрајински завод за заштиту споменика културе Петроварадин

Контакт особа:

Територијално надлежни завод: Покрајински завод за заштиту споменика културе Петроварадин

Број у централном регистру: АН 111

Датум уписа у централни регистар: 24/02/1995

Број у регистру Покрајинског завода за заштиту споменика културе Петроварадин: 4

Датум уписа у регистар Покрајинског завода за заштиту споменика културе Петроварадин: 27/01/1995

Решење Одлука о проглашењу за НКД: Решење Покрајинског завода за заштиту споменика културе у Новом Саду број 02-257/1-69 од 10.04.1969. године
[Resenje o zaštiti - Gradina, Novi Rakovac-pzzak NS br. 02-257_1-69 od 10.04.1969.PDF](#)

Категорија: Непокретно културно добро од великог значаја

Број и датум службеног гласила одлуке о категоризацији: "Службени лист Аутономне покрајине Војводине" број 28/91
[Odluka o kategorizaciji Sluzbeni list APV 28 od 29 decembra 1991. Gradina - Novi Rakovac.pdf](#)

Врста: Археолошко налазиште

Период настанка / датовање: Разни периоди (старије гвоздено, касноантички период, XI-XV)

Опис непокретног културног добра:
Локалитет „Градина“, споменик културе и археолошко налазиште, смештен је на узвишењу званом Градина, на путу Стручница у Новом Раковцу. Најстарији подаци о насељавању овог простора потичу из старијег гвозденог доба када је на овом месту постојало земљано утврђење – градина. У касноантичком периоду, на истој локацији, подигнуте су грађевине вероватно сакралног карактера. Следећу фазу континуитета живљења на овом месту, откривену дуготрајним систематским заштитним археолошким истраживањима, представља романска тробродна базилика у оквиру утврђеног манастирског комплекса. После налета Татара и рушења, на остацима романске базилике, уз употребу грађевинског материјала и фрагмената архитектонске пластике старије грађевине, подигнута је готска црква са пратећим објектима да би се у прелутурском периоду манастирски комплекс доградњама и ојачањем одбрамбених зидова претворно у утврђење. Дуг хронолошки распон живота

МАПА <<Преглед целе мапе>>

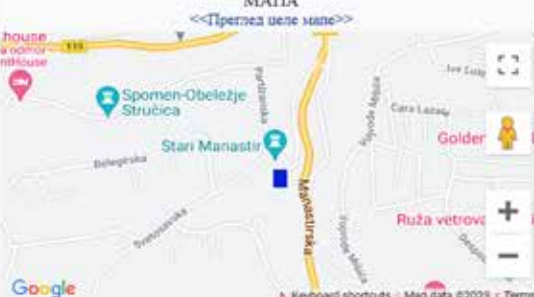


Фото документација:




Figure 2. Appearance of the public part of the IS NKD, https://nasledje.gov.rs/index.cfm/spomenici/pregled_spomenika?spomenik_id=44077 (accessed on November 27th 2023).

cultural property. Given that archaeological localities are also an important part of cultural heritage, everyone interested, not only employees of the protection service or scholars, but also the general public, can access basic information about the protection of an area as a cultural property. Additionally, more information can be found. In this way, the job of employees in the protection service and scientific workers has become easier. Also,

the popularisation of archaeological heritage has been broadened to a wider circle of citizens. For the visitors, obtaining information about the location of the sites can be of special importance, so that they can inform themselves better on particular sites before and during their trip, also gaining knowledge on sites that are not well known to the public, not adequately accessible, or not visible (underground), all of which will result in a better

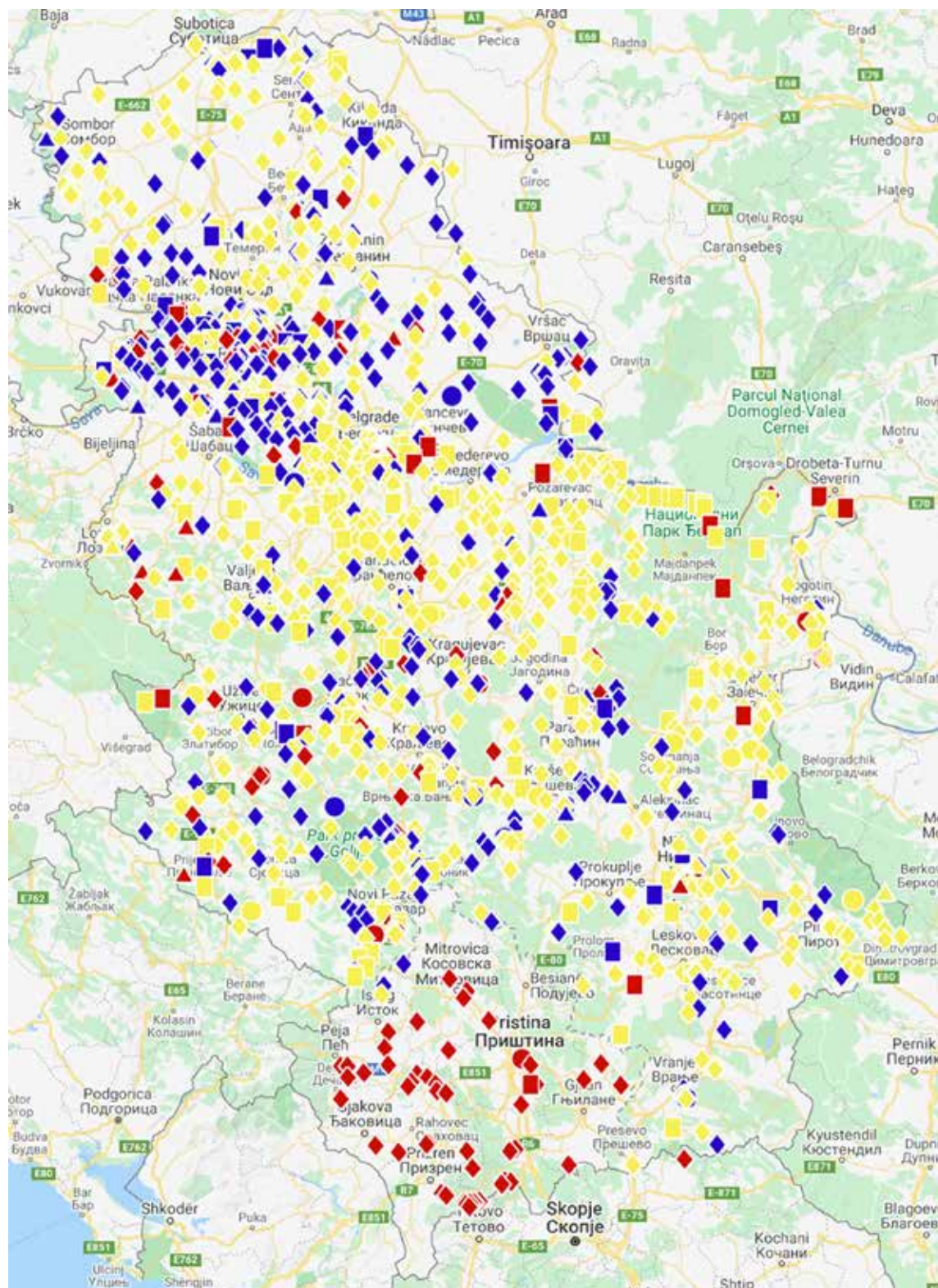


Figure 3. Map of Serbia indicating locations of immovable cultural property, <https://nasledje.gov.rs/index.cfm/index/index> (accessed on November 27th 2023).

Figure 4. Appearance of the detailed search facility of the IS NKD in English, https://nasledje.gov.rs/index.cfm/spomenici/pretraga_spomenika_new (accessed on November 27th 2023).

understanding of the historical development of the area they visit.

Part of the data from the IS NKD was incorporated into the Cultural Heritage Browser (Serbian: *Agregator kulturnog nasleđa*) (Arperator), a unified portal for the cultural heritage of the Republic of Serbia (Правилник 2018, Articles 2 and 12; Šegan-Radonjić and Tepavički-Ilić 2020: 218). In addition, part of the data is included in the National Spatial Data Infrastructure GeoSrbija (ГеоСрбија). In this way, scholars, experts, and people interested in archaeology can see more information related to a variety of localities.

CONCLUSION

Designated as one of the five basic information systems for the digitization of the cultural heritage of the Republic of Serbia, the Information system of Immoveable Cultural Property successfully fulfils its task. It stores data and documentation on the immovable cultural heritage of Serbia, including archaeological sites and localities. The visibility of cultural heritage is provided to experts, as well as to the public through free access to part of the data that exists within it.

Further development of the IS NKD is ahead of us. It should be expanded with fields for new types of documentation, and new software solutions will be sought to facilitate additional work with documentation. The IS NKD was formed based on the legislation of the Republic of Ser-

bia. That legislation defines the documentation that is created and preserved about every cultural property. Also, the system for the protection of immovable heritage in Serbia is different from other countries in the region, and in the rest of the world (only the Republic of Srpska [as an entity of Bosnia and Hercegovina] still has a system like Serbia). Therefore, it is not easy, nor in most cases possible, to use ready-made solutions that exist in the world. The comparison of the IS NKD with different information systems from around the world, and their eventual harmonisation, would also entail researching the differences in the legislation of the countries in which they are applied. This could represent a long-term task, which would not necessarily result in favourable outcomes. All of this speaks to the complexity of such a system and the need to involve experts from various fields in the work on its future improvement and development.

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REZIME

INFORMACIONI SISTEM NEPOKRETNIH KULTURNIH DOBARA KAO JEDAN OD INSTRUMENATA ZA PREZENTACIJU ARHEOLOŠKOG NASLEĐA SRBIJE

KLJUČNE REČI: NEPOKRETNO KULTURNO DOBRO, ARHEOLOŠKO NALAZIŠTE, DIGITALIZACIJA, INFORMACIONI SISTEM NEPOKRETNIH KULTURNIH DOBARA

Informacioni sistem nepokretnih kulturnih dobara (IS NKD) je jedan od pet osnovnih informacionih sistema za digitalizaciju kulturnog nasleđa Republike Srbije. U okviru njega se čuvaju podaci o zaštićenom nepokretnom kulturnom nasleđu Republike Srbije (nepokretnim kulturnim dobrima). Sastoji se od dva dela. Prvi je namenjen stručnjacima u oblasti zaštite nepokretnih kulturnih dobara i sadrži veći broj podataka. Drugi je namenjen javnosti i sadrži neophodne osnovne podatke, uključujući i mapu sa lokacijama nepokretnih kulturnih dobara. U IS NKD se nalaze podaci o pravnoj zaštiti nasleđa, druga obavezna dokumentacija koja po zakonodavstvu mora da postoji uz svaki zaštićeni lokalitet ili objekat, kao i prateća dokumentacija koja govori o istorijatu, vrednostima, svojstvima, stanju, obavljenim konzervatorsko-restauratorskim i drugim radovima na njima, itd. Jedna od vrsti nepokretnih kulturnih dobara su arheološka nalazišta, a arheološki lokaliteti mogu biti i jedno od preostale četiri vrste nepokretnih kulturnih dobara, ili njihov deo. U okviru IS NKD postoji i posebna celina predviđena za unos podataka o obavljenim arheološkim istraživanjima na predmetnom lokalitetu ili objektu. Podaci koji se unose su tekstualni, skenirani (najčešće u PDF formatu, a zatim u JPG i drugim formatima), ili oni koji su nastali u digitalnoj formi. Prezentovanje postojećih informacija o arheološkom nasleđu Republike Srbije nije namenjeno samo stručnjacima iz službe zaštite kulturnog nasleđa, već je jedan od ciljeva IS NKD da nasleđe približi i učini dostupnim i široj javnosti.

* * *

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Report article

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https://doi.org/10.18485/arhe_apn.2023.19.14DRAGAN PRLJA[✉]

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EUROPEAN APPROACH TO ARTIFICIAL INTELLIGENCE

ABSTRACT

The paper analyses how the institutions of the European Union approach solving the issue of the safe use of artificial intelligence. Documents from the Council of Europe, the European Parliament, and the European Commission are analysed. The Communication on the European Approach to Artificial Intelligence, of the European Parliament and the Council of Europe, the Coordinated Plans of the European Parliament and the Council of Europe for Artificial Intelligence, and the Proposal for the Regulation on Artificial Intelligence of the European Parliament and the Council of Europe were discussed. The goal of adopting all these documents is to create a safe environment for the use of artificial intelligence, that is, to create an adequate ethical and legal framework for the development and use of products and services based on artificial intelligence technologies. The European approach to the successful development of an environment for the use of artificial intelligence implies an accelerated investment in artificial intelligence technologies, the harmonization of artificial intelligence policies of individual EU countries, the creation of appropriate computing capacities, the construction and mobility of research capacities, the financing of innovative ideas and solutions, and the creation of adequate legal regulations for the safe use of artificial intelligence.

KEYWORDS: ARTIFICIAL INTELLIGENCE, EUROPEAN UNION, ARTIFICIAL INTELLIGENCE ACT.

INTRODUCTION

The development of new technologies has created potential dangers for individuals and companies, but high-quality legal regulation and its application in practice, along with an efficient system of sanctioning those who do not respect legal norms, is an adequate response that would lead to the creation of a well-ordered and safer society in the future (Prlja, Gasmi, Korać 2021: 128).

For many years, various institutions of the EU

have been trying to prepare regulations for an efficient application of artificial intelligence with the aim of ensuring a safe and controlled use of these systems. The European approach to artificial intelligence is focused on developing and using this technology in a responsible and ethical way, for the benefit of society as a whole. The first steps in this direction in Europe were made with the adoption of a series of strategic documents, recommendations and declarations by the institutions of the EU and the Council of Europe.

The most recent among these documents are

those published by the Council of Europe: *Declaration by the Committee of Ministers on the Manipulative Capabilities of Algorithmic Processes* in 2019 (Council of Europe 2019), *Recommendation CM/Rec of the Committee of Ministers to Member States on the Human Rights Impacts of Algorithmic Systems* in 2020 (Council of Europe 2020), and *Declaration by the Committee of Ministers on the Risks of Computer-Assisted or Artificial-Intelligence-Enabled Decision Making in the Field of the Social Safety Net* in 2021 (Council of Europe 2021).

The European Commission published *Building Trust in Human-Centric Artificial Intelligence* in 2019 (European Commission 2019), *White Paper on Artificial Intelligence – A European Approach to Excellence and Trust* in 2020 (European Commission 2020a), *Fostering a European approach to Artificial Intelligence* (European Commission 2021a) and its annexes - *Coordinated Plan on Artificial Intelligence 2021 Review* (European Commission 2021b) in 2021, as well as *Proposal for a Regulation of the European Parliament and the Council Laying Down Harmonised Rules on Artificial Intelligence (Artificial Intelligence Act) and Amending Certain Union Legislative Acts* (European Commission 2021c), together with its impact assessment (European Commission 2021d).

FOSTERING A EUROPEAN APPROACH TO ARTIFICIAL INTELLIGENCE

Fostering a European Approach to Artificial Intelligence from 2021 (European Commission 2021a), of the European Parliament and the Council of Europe, is a political document. It states that artificial intelligence had shown its potential in contributing to the fight against the Corona virus, helping to predict the geographical spread of the disease, diagnose the infection, and to develop vaccines and medications to fight the virus. The links between the creation of a regulatory framework for artificial intelligence and the *European Data Governance Act*, legislation on product safety (i.e., amendments in the *Machinery Directive*, dealing with safety risks resulting from cooperation of humans and robots and the use of autonomous machines), the *EU Cybersecurity Strategy*, *Digital Education Action Plan 2021–2027*,

proposals for the *Digital Services Act*, the *Digital Markets Act*, and the *European Democracy Action Plan*, and amendments to the *Product Liability Directive*. were also highlighted. In addition to a series of advantages brought by artificial intelligence, some dangers were also emphasised, such as unjustifiably putting individuals in a disadvantageous position through the use of artificial intelligence, endangering privacy through facial recognition in public spaces, etc., and for this reason, the *Proposal for a Regulation of the European Parliament and the Council Laying Down Harmonised Rules on Artificial Intelligence (Artificial Intelligence Act) and Amending Certain Union Legislative Acts* (European Commission 2021c) was prepared as a new legal regulatory framework, as well as the *Coordinated Plan on Artificial Intelligence* for member states in 2021 (European Commission 2021b).

COORDINATED PLANS

The *Coordinated Plan on Artificial Intelligence* of the European Parliament and the Council of Europe from 2018 (European Commission 2018) laid foundations for a harmonisation of policies on artificial intelligence and encouraged member states to work together to develop national strategies in this area and maximise the European Union's competitive potential in this field. It laid foundations for cooperation and defined the areas of further investment and was the first step in defining the common direction of the European artificial intelligence policy. The result of this joint plan were national strategies for artificial intelligence and investment in the development of artificial intelligence. The *Coordinated Plan on Artificial Intelligence* for the Member States for 2021 (European Commission 2021b) is the next step, which includes a set of joint actions of the European Commission, member states, and private stakeholders that include: accelerated investment in artificial intelligence technologies (through the Digital Europe programme – DEP, Horizon – HE, and the *Recovery and Resilience Facility* – RRF); acting in accordance with artificial intelligence strategies and programmes (Digital Innovation Hubs – DIH, robotics, *Internet of things*, etc.) and aligning artificial intelligence policies to avoid fragmentation.

Within the framework of the *Coordinated Plan on Artificial Intelligence* for the Member States for 2021, the plan is to implement measures within four areas.

The first area is *setting enabling conditions for artificial intelligence development in the EU*. It includes the unification and sharing of policies in the artificial intelligence field, harnessing of the potential of data, and fostering critical computing capacities. This set of measures enables the creation of the infrastructure necessary for the development and application of artificial intelligence with appropriate investment.

Within the second area, measures are defined that would make the EU a leader in the artificial intelligence development *from the laboratory to the market*: collaboration with stakeholders through European Partnerships for Artificial Intelligence, collaboration in the fields of data, robotics and expert groups, building and mobility of research capacities, providing environments for developers to test and experiment, and for small and medium companies and public administrations to take over technological solutions, and financing innovative ideas and solutions.

The third area is the *application of artificial intelligence for the benefit of people and the development of society*. In this context, the following set of measures is planned: honing talents and improving skills necessary to create a successful artificial intelligence ecosystem, developing political measures in order to ensure trust in artificial intelligence systems and promoting a vision of the EU with sustainable and reliable artificial intelligence. In this manner, it would be ensured that artificial intelligence placed on the EU market would be sustainable, safe, accessible and reliable.

The fourth area includes a group of measures related to *building strategic leadership and progress in high-impact sectors*: climate and environment, health, robotics, public administration, law enforcement, migration and asylum, agriculture, etc.

PROPOSAL FOR ARTIFICIAL INTELLIGENCE ACT

A key step in achieving political goals in the artificial intelligence field in Europe is the *Pro-*

posal for a Regulation of the European Parliament and the Council Laying Down Harmonised Rules on Artificial Intelligence (Artificial Intelligence Act) and Amending Certain Union Legislative Acts (European Commission 2021c) of the European Parliament and the Council of Europe. The essence of this legal act is that it is focused on questions of safety and respect of fundamental rights in the use of artificial intelligence technologies. It provides a risk-based definition of artificial intelligence and sets mandatory requirements for high-risk artificial intelligence systems. It also envisions a governance mechanism that covers *ex ante* compliance assessments and *ex post* compliance control systems. Artificial intelligence systems that do not fall into the high-risk category are subject to existing legislation and have an obligation of transparency, and can voluntarily comply with the requirements of the *Proposal* on the basis of a code of conduct or another self-regulatory system.

The EU approach in the *Proposal* in terms of the challenges arising from the use of artificial intelligence is based on a special treatment of high-risk artificial intelligence systems. For high-risk systems that create a high risk for the health, safety and fundamental rights of individuals, special rules and mechanisms for the application of those rules are established. Those rules establish legal requirements in terms of data and data management, documentation and record keeping, transparency and user information, human control, resilience, and accuracy and security, all of which apply to manufacturers, importers, distributors, authorised representatives and users.

It is foreseen that the *European Committee for Artificial Intelligence* would be established at the level of the European Union, and that bodies that would determine compliance with the requirements of the Act, as well as supervisory bodies, would be established at the level of individual countries. The European Committee for Artificial Intelligence consists of representatives of the member states and the European Commission. National conformity assessment bodies would be appointed by the competent national body, and they would assess the conformity with reliable quality management and risk management systems. Also, they would monitor a given artificial intelligence system after it is placed on the market and issue

certificates on its compliance with the requirements of the Act. The national supervisory body would control the implementation and drastically fine manufacturers who do not comply with the prescribed provisions, with fines of up to 30 million euros, or up to 6% of the total annual turnover of the given company in the worldwide territory for the previous financial year. In addition to these binding legal norms, the proposed legal regulation mechanism foresees the creation of a code of conduct that would be voluntarily adhered to by manufacturers of high-risk artificial intelligence systems, as well as manufacturers of artificial intelligence systems that are not high-risk.

The *Proposal for a Regulation of the European Parliament and the Council Laying Down Harmonised Rules on Artificial Intelligence (Artificial Intelligence Act) and Amending Certain Union Legislative Acts* contains an *Explanatory Memorandum, Proposal and Annexes*.

The *Explanatory Memorandum* is very detailed and contains five parts. The first part provides the context for the Proposal, that is to say, the reasons and objectives of the Proposal are listed, as well as an overview of consistency with existing policy provisions in the policy area and consistency with other Union policies. The second part provides the legal basis, with the explication of subsidiarity and proportionality, as well as the choice of the legal instrument. The third part of the *Explanatory Memorandum* is dedicated to the presentation of the results of *ex-post* evaluations, stakeholder consultations and impact assessment, with a special overview of regulatory fitness and simplification and the relationship with fundamental rights. In the fourth part, budgetary implications that would occur after the adoption of the regulations are discussed. The fifth part of the *Explanatory Memorandum* included implementation plans, as well as monitoring, evaluation and reporting arrangements, along with a detailed explanation of the specific provisions of the *Proposal* by chapter.

The *Proposal* contains a preamble with 89 points and twelve chapters with 85 articles. In the first title – *General Provisions*, the subject matter of the Act is specified, as well as the scope of its application, and definitions of 44 terms are given, including the definition of artificial intelligence systems; also, amendments to Annex I of the Act are defined. The second title – entitled *Prohibited*

artificial intelligence practices, contains a list of practices in the field of artificial intelligence that are prohibited.

The third title – *High-Risk AI Systems*, provides, in the first chapter, the classification rules for high-risk artificial intelligence systems and defines the amendments to Annex III of the Act. The second chapter of this title defines requirements for high-risk artificial intelligence systems, risk management system, data usage, technical documentation principles, record-keeping principles for high-risk systems, principles for transparency and the provision of information to users, human oversight of the functioning of artificial intelligence systems, as well as the technical robustness and cybersecurity of artificial intelligence systems. The third chapter of this title defines obligations of providers of artificial intelligence systems (quality management system, obligation to draw up technical documentation, conformity assessment, automatic generation of event logs, corrective measures, duty of information, cooperation with competent authorities, and obligations of product manufacturers, representatives, importers and distributors), obligations of users of high-risk artificial intelligence systems and obligations of third parties.

The fourth chapter of this title is dedicated to the authorities responsible for the appointment of conformity assessment bodies and designated conformity assessment bodies and includes the method of submitting an application of a conformity assessment body for notification, the notification procedure, obligations and the method of functioning of the notified conformity assessment bodies, subsidiaries and subcontracting by notified bodies, assigning identification numbers and maintaining the list of designated notified bodies, the method of making changes to notifications, the method of challenging the competence of the designated notified body, the method of coordination and cooperation of the designated notified bodies and the relationship with the conformity assessment bodies of third countries. The fifth chapter provides an elaboration on the manner of assessing conformity on the basis of standards and common specifications, issuing certificates on conformity, the appeal procedure against decisions of notified bodies responsible for conformity assessment, information obligations of notified

bodies, derogation from conformity assessment procedure, EU declaration of conformity, CE marking of conformity, document retention and registration in the EU database of high-risk artificial intelligence systems. The fourth title defines *transparency obligations for certain artificial intelligence systems*, especially in those for emotion recognition, biometric categorisation, and those that manipulate image, audio or video content that appreciably resemble existing persons, objects, places, events, etc.

The fifth title is dedicated to *measures in support of innovation*, first and foremost to isolated artificial intelligence environments with a special legal framework and measures, taken for small manufacturers and users of artificial intelligences systems. The sixth title is dedicated to the *governance system* and is divided into two chapters. The first defines the structure and tasks of the European Artificial Intelligence Board, while the second chapter defines the procedure for designating national competent authorities. The seventh title is dedicated to the founding and management of a unique *database* with registered high-risk artificial intelligence system by the European Commission. The eighth title defines, in several chapters, the *monitoring system* of high-risk artificial intelligence system after they reach the market, the sharing of information on incidents and malfunctioning of these systems and market surveillance and control in the EU market and at a national level. The ninth title is dedicated to *codes of conduct* for artificial intelligence system that are not high-risk. *Information and data confidentiality and penalties* for infringement of the terms of the Act (administrative fines) are the topic of the tenth title. *Delegation of power* is the topic of the eleventh title of the Act. The twelfth title – *Final provisions*, contains articles with amendments to certain Regulations of the EU in order to gain conformity with the Act, as well as articles with regulation for artificial intelligence system already placed on the market, as well as articles dealing with evaluation and the need for review, in the future, of regulations and entry into force of the Act.

Nine annexes provided with the EU *Proposal on Artificial Intelligence Act* define techniques and approaches for artificial intelligence systems, provide a list on Union harmonisation legislation,

a list of high-risk artificial intelligence systems, and also define obligations regarding technical documentation. Additionally, elements of the EU Declaration of conformity are defined, as well as the conformity assessment procedure based on internal control, on the basis of assessment of quality management system, and on the basis of assessment of technical documentation; also, the group of information that is to be submitted upon the registration of high-risk artificial intelligence systems to the EU database, managed by the European Commission, and Union legislation is listed that regulate the functioning of large information systems in the area of freedom, security and justice.

At the national level, the member states of the EU are obliged to harmonise their legislation with the provisions of the *Artificial Intelligence Act* once it is adopted. It is also expected that countries that want to become members of the EU would also harmonise their legislation with the provisions of the Act and build mechanisms that would enable the safe use of high-risk artificial intelligence systems, as well as legal safety. The complex legal framework requires the adoption of new regulations and the amendment of existing ones, both those with a binding effect and those that do not have a binding effect. The first category certainly includes a special law on artificial intelligence with a strict sanctioning mechanism that would ensure effective implementation. The experience with the EU's General Data Protection Regulation (GDPR) has shown how high monetary fines affect compliance with legal regulations. The second category of non-binding rules includes professional codes of conduct at the national level and recommendations and declarations, primarily by international organisations, such as the Council of Europe.

CONCLUSION

The extremely dynamic development of technologies today places high demands on the legal system, which should regulate the new reality based on algorithms. It is necessary to quickly adapt legal norms and in areas that open up a number of new dilemmas and questions: autonomous behaviour of artificial intelligence systems, legal subjectivity of artificial intelligence, liability for

damage caused by artificial intelligence systems, new professional and ethical standards, etc. Due to the extreme complexity and speed with which these changes occur, a clear regulatory framework must be based on the co-regulatory principle of general binding instruments and detailed sectoral non-binding instruments (Ben-Israel, I., *et al.* 2020: 90).

As a result of the technological complexity of artificial intelligence systems, it is not easy to legally regulate the use of algorithms and to protect fundamental rights and freedoms, but it certainly is possible and, in fact, necessary (Zuiderveen Borgtesius, F. 2018: 63)

The European approach to artificial intelligence includes the adoption of a series of strategic documents that should ensure the safe and effective use of artificial intelligence in all areas of life. The guidelines on artificial intelligence of the Council of Europe recommend ensuring the protection of privacy and personal data, during both the construction and operation of artificial intelligence systems. Citizens should have full control over their own data, and their data should not be used if there is a possibility of harm or discriminatory behaviour.

One of the areas where artificial intelligence has found its use is the research, preservation and presentation of cultural heritage. For example, through the integration of artificial intelligence into archaeological research processes, new perspectives have been opened for the study of past civilizations and archaeological sites. The use of machine learning and data analysis can enable archaeologists to process and interpret large amounts of data more quickly and accurately. In this way, artificial intelligence can help in the restoration and reconstruction of archaeological artifacts and sites, as well as in the sites' detection, which can provide a deeper understanding of past cultures as well as the preservation and presentation of cultural heritage. However, while using artificial intelligence in the area of cultural heritage, many ethical and other considerations can be raised, such as selection of data and its reliability, possible biased interpretations of data, protection of specific data and data control with copyright, as well as the question of authenticity challenged by reconstructions (Bickler 2021: 189; Pansoni *et al.* 2023: 1149-1155; European Commission 2020b: 147).

In the near future, artificial intelligence will significantly affect the development of the economy and the competitiveness of EU countries on the world market. Therefore, it is important to create an adequate environment for the control of high-risk artificial intelligence systems as soon as possible with maximum respect for all ethical and legal rules, with the aim of the safe use of artificial intelligence. The development and use of products and services based on artificial intelligence technologies in the EU should be accompanied by adequate financial support for innovations and new ideas, but also by precise legal regulation and the adoption of adequate ethical rules in order to eliminate all potential dangers of possible abuse.

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REZIME

EVROPSKI PRISTUP VEŠTAČKOJ INTELIGENCIJI

KLJUČNE REČI: VEŠTAČKA INTELIGENCIJA, EVROPSKA UNIJA, PREDLOG UREDBE O VEŠTAČKOJ INTELIGENCIJI.

U radu se analizira na koji način institucije Evropske unije pristupaju rešavanju pitanja bezbedne upotrebe veštačke inteligencije. Analiziraju se dokumenti Saveta Evrope, Evropskog parlamenta i Evropske komisije. Razmatrani su *Saopštenje o evropskom pristupu veštačkoj inteligenciji*, koordinisani planovi za veštačku inteligenciju i *Predlog uredbe o veštačkoj inteligenciji*. Cilj donošenja svih ovih dokumenata je stvaranje bezbednog okruženja za korišćenje veštačke inteligencije, odnosno stvaranje adekvatnog etičkog i pravnog okvira za razvijanje i upotrebu proizvoda i usluga baziranih na tehnologijama veštačke inteligencije. Evropski pristup uspešnom razvoju okruženja za upotrebu veštačke inteligencije podrazumeva ubrzano ulaganje u tehnologije veštačke inteligencije, usklađivanje politika veštačke inteligencije pojedinih zemalja Evropske Unije, stvaranje odgovarajućih računarskih kapaciteta, izgradnju i mobilnost istraživačkih kapaciteta, finansiranje inovativnih ideja i rešenja, i stvaranje adekvatne pravne regulative za bezbedno korišćenje veštačke inteligencije.

* * *

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PRIKAZI - BOOK REVIEWS

Slađana Rajković, Julijana Pešić, Mira Ninošević, Smilja Jović, Aleksandra Grgov i Jelena Radović, ODELO NE ČINI ČOVEKA, ALI GOVORI O NJEMU (Odevanje i kićenje u leskovačkom kraju od praistorije od savremenog doba) / A SUIT DOES NOT MAKE A MAN, BUT IT TALKS ABOUT HIM (Clothing and embellishment in the Leskovac area from prehistory to the modern time), katalog izložbe, izdavač Narodni muzej Leskovac, Leskovac 2021. Publikacija sadrži 28 stranica i 48 ilustracija. ISBN 978-86-81865-45-3.

Muzealci Narodnog muzeja Leskovac navikli su stručnu i širu publiku na zanimljive i zapažene izložbe. Trend je nastavljen priređivanjem izložbe pod nazivom *Odelo ne čini čoveka, ali govori o njemu (Odevanje i kićenje u leskovačkom kraju od praistorije do savremenog doba)*. Za nastanak ovog projekta pobrinuo se autorski tim u sastavu Slađana Rajković, Julijana Pešić, Mira Ninošević, Smilja Jović, Aleksandra Grgov i Jelena Radović. Koncept izložbe je delo Mire Ninošević, dok dizajn postavke i vizuelni identitet izložbe predstavlja dostignuće koje potpisuje Radmila Krstić. Dostignut stepen konzervacije izloženih predmeta plod je rada Ivana Stojanovića.

Postavka je koncipirana tematski, uz poštovanje hronoloških principa. U dve izložbene galerije leskovačkog muzeja, priča o odevanju teče podeljena na devet tematskih celina. Prikazana je istorija kićenja i odevanja u leskovačkom kraju, koja prati period od više milenijuma. Predstavljeni su muzejski eksponati iz arheoloških, istorijskih i etnografskih zbirki.

Prvo poglavlje priče o odevanju smešteno je u doba neolita. Zaključci su doneti na osnovu predstava odela na antropomorfnim figurinama od terakote. Smatra se da se osnovna garderoba neolitskog čoveka sastojala iz dva osnovna dela – košulje i ukrašene suknje. Dekoracija izvedena na figurinama prikazuje i nakit, za koji se smatra da je imao magijsko-apotropejsku funkciju što je, kao trivija, posebno naglašeno u katalogu.

Priča o nakitu nastavlja se kroz period metalnih doba, s tim što je ilustrovana originalnim eksponatima, poput naočarastih fibula i torkvesa sa T krajevima. Na navedenim predmetima domi-

nantan je motiv spirale, za koji trivija navodi da je *simbol kružnog kretanja i ponavljanja ritma života koji naizmenično prolazi kroz dobro i zlo*.

Rimsko doba oslikava podela odeće, iako bazirane na jedinstvenoj osnovi, na jednostavnu kakvu su nosili pripadnici siromašnijih slojeva i raznobojnu, izrađenu od najfinijih tkanina, dobavljenu iz raznih krajeva Carstva, kakva je bila dostupna višim krugovima tadašnjeg društva. Garderoba je dodatno ukrašavana dekorativnim elementima poput fibula, privezaka, kopči i aplikacija. Eksponati ovog tipa, često izrađeni od plemenitih metala, predstavljeni su putem nalaza otkrivenih na antičkoj nekropoli u Maloj Kopašnici. U okviru nalaza iz Male Kopašnice posebno se ističe kolekcija zlatnog ženskog nakita kojim su, rečima istaknutim u triviji, tadašnje dame *vratove i dekoltee ukrašavale ogrlicama, lancima i raznim privescima, a ruke narukvicama i prstenjem*.

Tokom VI veka, odnosno ranovizantijskog perioda, nastavljaju se tradicije oblačenja i kićenja iz rimskog perioda. Moderan je bio polihromni nakit od dragog ili poludragog kamena, umetnutog u okvir od metala. Skromniji komadi rađeni su od staklene paste, dok se javlja i ukrašavanje nastalo primenom tehnika filigrana i granulacije. Često se koriste dekorativni motivi sa hrišćanskom simbolikom, ali i univerzalni motivi spirale. Naglašava se da su *na Caričinom gradu otkriveni delovi kozmetičkog pribora koje su žene koristile kako bi istakle i negovale svoju lepotu*.

U srednjovekovnoj Srbiji odeća je predstavljala simbol društvenog statusa. Autori opisuju srednjovekovni muški i ženski plemićki kostim, kao i njegovu komparaciju u odnosu na seosku

nošnju. Isti metodološki princip primenjen je i na nakit. Skrenuta je pažnja na prstenje, za koje je naglašeno da su *na glavi prstena urezani kružići, tačkice u obliku krsta i kompozicije vezane za život Hrista, Bogorodice i svetitelja*. Posebno je istaknut i prsten koji je mogao pripadati Mari, ženi velikaša Nikole Skobaljića.

U vremenu turske okupacije leskovačkog kraja (1454–1878. godine), život se odvijao po pravilima Osmanskog carstva. Autori naglašavaju zabrane, odredbe i prilagođavanja odevanja i kićenja kod seoskog i gradskog stanovništva. Poseban prostor podaren je ukrasnim iglama za glavu i prstenovima „stolovatima“, za koje se kaže da su nošeni *samo za vreme svečanosti za stolom, zato što, zbog svoje veličine, nisu mogli da služe kao svakodnevni ukras*.

Tokom druge polovine XX veka, način života i odevanje Leskovčana razvijali su se prvo pod turško-orijentalnim uticajem, a nakon oslobođenja i priključenja matici dolazi do razvoja po ugledu na ostale delove Srbije. Opisuje se način odevanja stanovništva koji zadržava određene orijentalne elemente, ali prihvata i srpski građanski kostim. Opisuje se i razlika između građanske i seoske nošnje i načina njihovih izrada. *Građanska nošnja balkansko-orijentalnog stila, izrađena je od skupocenih tkanina sa bogatim zlatnim i srebrnim vezom, bila je visokokvalitetne izrade. Tako je nastao građanski kostim, kao kombinacija orijentalnih i evropskih elemenata, čiji su najreprezentativniji delovi libade zvonastih rukava i bogato ukrašeni tepeluk kao ogavlje*.

Priča o odevanju u leskovačkom kraju zaključuje se segmentom posvećenim periodu od 1900. do 1941. godine. Kapital stican od kraja XIX veka omogućio je ekonomski procvat Leskovca u vremenu između dva svetska rata i razvijanje građanske klase koja je podržavala zapadnjačku modu, o čemu svedoče brojne sačuvane fotografije. Narodno odevanje se zadržalo na selu, a njegovi delovi su korišćeni do kasnih pedesetih godina XX veka. *Ulice međuratnog Leskovca krasila je raznolikost arhitektonskih rešenja i modno šarenilo, na kojima se mogla sresti starija gospođa sa minuciuzno izrađenim jelekom i libadetom, ali i moderna dama sa šeširrom*.

Izložbu prati bogato ilustrovan katalog, sa kratkim ali veoma informativnim i interesantnim

tekstovima. Deo teksta publikovan je uporedo na srpskom i engleskom jeziku (prevod: Gabrijela Ilić).

Ljubiša VASILJEVIĆ

Teodora Branković, KONZERVIRANI SPOMENICI IZ LAPIDARIJUMA ANTIČKE ZBIRKE NARODNOG MUZEJA POŽAREVAC / CONSERVATION OF STONE MONUMENTS FROM ANTIQUE COLLECTION OF NATIONAL MUSEUM OF POZAREVAC, izdavač Narodni muzej Požarevac, Požarevac 2022. Publikacija sadrži 63 stranice (uvod, tri tematske celine, spisak literature sa 53 bibliografske jedinice i 6 jedinica iz muzejske dokumentacije, rezime na engleskom jeziku (prevod: Natalija Milojković) i katalog sa 34 kataloške jedinice raspodeljene u okviru sedam vrsti spomenika). ISBN 978-86-84147-57-0.

Publikacija, čije autorstvo potpisuje Teodora Branković, predočava procese realizacije i rezultate multidisciplinarnog arheološko-konzervatorsko-muzeološkog projekta posvećenog antičkim spomenicima iz zbirke Narodnog muzeja Požarevac.

Prve rečenice *Uvoda* opisuju nastanak, razvoj i trenutno stanje antičke arheološke zbirke Narodnog muzeja Požarevac, sa posebnim naglaskom na kamene i mermerne spomenike. Predstavljen je i osvrt na početke prikupljanja nalaza u Požarevcu i osnivanje Muzeja. Naglašava se da je u cilju očuvanja spomenika, kao neprocenjive kulturne baštine, realizovan projekat pod nazivom *Konzervacija kamenih spomenika iz lapidarijuma Antičke zbirke Narodnog muzeja u Požarevcu* koji je, u saradnji sa tadašnjim Centralnim institutom za konzervaciju (CIK), realizovan u periodu od 2012-2020. godine.

Poglavlje *Lapidarijum* predstavlja podatke o navedenom prostoru, smeštenom u dvorištu centralne zgrade požarevačkog muzeja, čija površina iznosi oko 450 m². U lapidarijumu je izloženo više od stotinu antičkih kamenih spomenika. Najzastupljeniji su slučajni nalazi sa šireg područja Viminacijuma, ali sadrži i spomenike sa čitave teritorije Braničeva.

Autorka nam pruža osvrt na prvi lapidarijum u Požarevcu, osnovan pri Gimnazijskoj zbirci krajem XIX veka. Na žalost, samo jedan sarkofag iz prvobitne zbirke uspeo je da bude spasen od strahota iz dva svetska rata. Gimnazijska zbirka poslužila je kao osnova za nastanak Narodnog muzeja Požarevac. Postoji više mogućih datuma

osnivanja Muzeja, ali se za zvaničan uzima 22. jun 1896. godine.

Spomenici u današnjem lapidarijumu izrađeni su od više vrsta kamena. Najviše je korišćen krečnjak, ali postoje i primerci od belog mermera, mermera u boji, breče i peščara. Izloženi eksponati su različitog karaktera i dimenzija, a vremenski okvir je od I do IV veka. Potiču iz Viminacijuma, Marguma, Lederate i Municipijuma (Kalište). Uglavnom je reč o slučajnim nalazima.

Autorka predstavlja i osnovne podatke o vrstama spomenika, sačuvanim epigrafskim podacima koje nam oni pružaju i upotrebljenim dekorativnim motivima. Analiza spomenika svedoči o prosperitetu koji Viminacijum doživljava u drugoj polovini II i III veku. Iz tog perioda potiču importovani spomenici, izrađeni od mermera, ali i spomenici od krečnjaka koji su delo majstora iz lokalnih radionica.

Poseban značaj ima poglavlje *Projekat konzervacije*, koje svojim kratkim i jasnim naslovom svedoči o velikom poduhvatu pokrenutom od strane požarevačkog muzeja. Nakon što su delovanje atmosferalija i neumitan protok vremena doveli do ubrzanog procesa propadanja spomenika, kustosi požarevačkog muzeja, u saradnji sa CIK-om, pripremili su i obavili kompleksne konzervatorsko-restauratorske tretmane na ugroženom kulturnom nasleđu. Detaljno su opisani tokovi realizacije i rezultati sprovedenog multidisciplinarnog arheološko-konzervatorsko-muzeološkog projekta, čiji je nosilac (u prve dve faze zajedno sa kolegicom Draganom Spasić-Đurić), ispred Narodnog muzeja Požarevac, bila autorka publikacije, Teodora Branković.

Tekst detaljno predočava elaborat projekta i predviđene mere zaštite, sve faze realizacije projekta, tipološku podelu spomenika iz zbirke, konzervatorske tretmane primenjene na svakom pojedinačnom eksponatu, konzervatorske kartone, planove za buduću zaštitu i izlaganje konzerviranih predmeta i predstavljanje rezultata projekta putem izložbi i pratećih programa.

U okviru *Zaključnih razmatranja* opisani su problemi i iskustva iz prakse vezani za izlaganje i prezentaciju spomenika u lapidarijumu. Istovremeno se izražava nada i potreba da projekat bude nastavljen i da se pristupi konzervaciji preostalih spomenika iz zbirke Muzeja.

Nakon spiska korišćene stručne literature i rezimea na engleskom jeziku, započinje drugi deo publikacije sa katalogom konzerviranih spomenika.

Katalog obuhvata 34 kataloške jedinice razvrstane, po vrsti spomenika, na sedam celina (sarkofazi, nadgrobni spomenici, žrtvenici, ploče sa natpisima, kamene posude, arhitektonski elementi i skulpture). U okviru svake kataloške jedinice predstavljeni su inventarni broj eksponata, lokalitet, materijal i način izrade, detaljan opis (uključujući i epigrafiku), literatura sa podacima o spomeniku i opis sprovedenih konzervatorsko-restauratorskih radova.

Tematika je obrađena na profesionalan, ali i prijemčiv način, uz poštovanje svih principa arheologije, muzeologije i konzervacije. Publikacija predstavlja značajan doprinos stručnoj literaturi i putokaz za pripremu i realizaciju budućih poduhvata ove vrste.

Ljubiša VASILJEVIĆ

UREĐIVAČKA POLITIKA ČASOPISA *ARHEOLOGIJA I PRIRODNE NAUKE*

Časopis *Arheologija i prirodne nauke* posvećen je temama iz humanističkih naučnih disciplina: arheologije, istorije, klasične filologije, istorije umetnosti i arhitekture, socijalne i kulturne antropologije; temama iz multidisciplinarnih istraživanja koja povezuju arheologiju i prirodne nauke: fizičke (bio) antropologije, arheometrije, geonauka u arheologiji, tehnologija u arheološkoj prospekcijskoj; temama koje se bave zaštitom i prezentacijom arheološkog nasleđa: konzervacijom i restauracijom kulturnog nasleđa, eksperimentalnom arheologijom, interpretacijom arheološkog nasleđa, digitalnom arheologijom, kompjuterskim i informacionim tehnologijama, arheološkom dokumentacijom; i drugim temama povezanim sa arheologijom.

Časopis *Arheologija i prirodne nauke* kao periodična publikacija izlazi od 2006. godine, i predstavlja glasilo Arheološkog instituta iz Beograda i Centra za nove tehnologije Viminacium.

Časopis *Arheologija i prirodne nauke* objavljuje originalne, prethodno neobjavljene rukopise: istraživačke radove, pregledne radove, izveštaje, metodološke radove, studije slučaja i prikaze.

Časopis *Arheologija i prirodne nauke* je dostupan u režimu otvorenog pristupa.

Postupak predavanja rukopisa, recenzija i objavljivanje rukopisa su besplatni.

Jezici na kojima se mogu predati rukopisi su engleski, nemački ili francuski. Rezime mora biti na srpskom jeziku - latinica (za domaće autore) ili engleskom jeziku - standardni britanski (za inostrane autore).

Rukopisi za objavljivanje u časopisu predaju se sekretaru redakcije, a prema UPUTSTVU ZA AUTORE o načinu pripreme rukopisa.

Časopis *Arheologija i prirodne nauke* izlazi jedanput godišnje.

Časopis *Arheologija i prirodne nauke* se indeksira u bazi ERIH+.

Digitalne kopije svezaka časopisa *Arhe-*

ologija i prirodne nauke arhiviraju se na veb sajtu *Viminacium – Rimski grad i vojni logor* (<http://viminacium.org.rs/e-biblioteka/arheologija-i-prirodne-nauke/>), kao i u Narodnoj biblioteci Srbije, kojoj se predaje obavezni elektronski primerak, a pojedinačni radovi se arhiviraju u RAI – Repozitorijumu Arheološkog instituta (<https://rai.ai.ac.rs/>).

OBAVEZE UREDNIKA I REDAKCIJE (UREĐIVAČKOG ODBORA)

Redakcija časopisa *Arheologija i prirodne nauke* donosi konačnu odluku o tome koji će se rukopisi objaviti. Prilikom donošenja odluke redakcija se rukovodi UREĐIVAČKOM POLITIKOM vodeći računa o zakonskim propisima koji se odnose na klevetu, kršenja autorskih prava i plagiranje.

Redakcija zadržava diskreciono pravo da primljene rukopise proceni i ne objavi, ukoliko utvrdi da ne odgovaraju propisanim sadržinskim i formalnim kriterijumima. U redovnim okolnostima, redakcija obaveštava autora o tome da li je prihvatila tekst najduže u roku od 120 dana od datuma prijema rukopisa.

Redakcija ne sme imati bilo kakav sukob interesa u vezi sa rukopisima koje razmatra. Ako sukob interesa postoji kod jednog ili više članova redakcije, ti članovi se isključuju iz postupka izbora recenzenata i odlučivanja o sudbini rukopisa. Glavni i odgovorni urednik, urednici i članovi redakcije su dužni da blagovremeno prijave postojanje sukoba interesa.

Redakcija je dužna da sud o rukopisu donosi na osnovu njegovog sadržaja, bez rasnih, polnih/rodnih, verskih, etničkih ili političkih predrasuda.

Glavni i odgovorni urednik, urednici i članovi redakcije ne smeju da koriste neobjavljen materijal iz predatih rukopisa za svoja istraživanja

bez izričite pisane dozvole autora, a informacije i ideje iznesene u predatim rukopisima moraju se čuvati kao poverljive i ne smeju se koristiti za sticanje lične koristi.

U časopisu *Arheologija i prirodne nauke* sprovodi se sistem *double-blind* recenziranja rukopisa. Glavni i odgovorni urednik, urednici i članovi redakcije dužni su da preduzmu sve razumne mere kako bi identitet recenzenata ostao nepoznat autorima pre, tokom i nakon postupka recenzije i kako bi identitet autora ostao nepoznat recenzentima do okončanja postupka recenzije.

Rukopise pripremljene za štampu treba predati sekretaru redakcije, do 30. aprila za svesku koja izlazi do kraja tekuće godine. Redakcija se sastaje nakon predaje svih rukopisa i na prvom sastanku redakcije biraju se recenzenti.

OBAVEZE AUTORA

Autori garantuju da rukopis predstavlja njihov originalan doprinos, da nije objavljen ranije i da se ne razmatra za objavljivanje na drugom mestu. Istovremeno predavanje istog rukopisa u više časopisa predstavlja kršenje etičkih standarda. Takav rukopis se momentalno isključuje iz daljeg razmatranja.

Autori takođe garantuju da nakon objavljivanja u časopisu *Arheologija i prirodne nauke*, rukopis neće biti objavljen u drugoj publikaciji na nekom drugom jeziku bez saglasnosti izdavača.

Ako je rukopis prethodno bio razmatran za objavljivanje u drugom časopisu, autorima se preporučuje da informišu redakciju o ishodu tog recenzentskog postupka, odnosno da objasne u kojoj meri su uzeli u obzir primedbe recenzenata i/ili zašto ih nisu prihvatili. To je u interesu autora, zato što ove informacije mogu da pomognu urednicima prilikom izbora recenzenata.

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Autori su dužni da se pridržavaju etičkih standarda koji se odnose na naučnoistraživački

rukopis. Autori garantuju i da rukopis ne sadrži neosnovane ili nezakonite tvrdnje i ne krši prava drugih. Izdavač neće snositi nikakvu odgovornost u slučaju ispostavljanja bilo kakvih zahteva za naknadu štete.

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Redakcija časopisa *Arheologija i prirodne nauke* se stara o tome da objavljeni radovi sadrže dovoljno podataka na osnovu kojih bi se istraživanja opisana u radovima mogla ponoviti (reprodukovati). Iznesene činjenice treba detaljno opisati i potkrepiti referencama kako bi se recenzentima, a potom i čitaocima, omogućilo da provere tvrdnje koje su u njemu iznesene – npr. treba dati detaljan opis korišćenih metoda i slično. Autori su dužni da se upoznaju sa standardima koji se odnose na različite tipove naučnog rada (Equator Network) i koriste one koji su primereni njihovom istraživanju. Namerno iznošenje netačnih tvrdnji predstavlja kršenje etičkih standarda. Prikazi i stručni članci moraju biti precizni i objektivni.

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Međunarodni odbor urednika medicinskih časopisa (International Committee of Medical Journal Editors - ICMJE). Kao autor se može navesti samo ono lice koje je:

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- organizacija koja finansira neko lice, isplaćuje mu zaradu ili drugu vrstu materijalne nadoknade, ili kod koje je to lice deoničar, mogla bi imati finansijsku korist (ili gubitak) u slučaju objavljivanja rezultata;
- pojedinci, organizacija koja ih finansira, ili poslodavac su vlasnici patenta koji je u vezi sa rezultatima rada, ili su u procesu prijave takvog patenta;
- zvanična afilijacija i članstvo u interesnim grupama koje su u vezi sa objavljenim sadržajem;
- politički, verski ili ideološki sukob interesa.

Autori zaposleni u kućama ili komercijalnim organizacijama koje sponzorišu klinička ili terenska ispitivanja ili neki drugi vid istraživanja treba da navedu tu činjenicu kao sukob interesa prilikom dostavljanja rukopisa. U odeljku „Sukob interesa“ treba objasniti odnos svakog pojedinca autora sa takvim organizacijama. Radovi objavljeni u časopisu ne smeju da reklamiraju komercijalne proizvode.

Podaci o finansiranju

Ako je rad nastao kao rezultat projekta, autori su dužni da navedu izvore finansiranja u skladu sa ugovorom sa finansijerom.

Greške u objavljenim rukopisima

U slučaju da autori otkriju važnu grešku u svom rukopisu nakon njegovog objavljivanja, dužni su da momentalno o tome obaveste glavnog i odgovornog urednika ili izdavača i da sa njima sarađuju kako bi se rukopis povukao ili ispravio.

ORCID

ORCID (Open Researcher and Contributor ID) identifikatori svih autora navode se prilikom slanja rukopisa i biće objavljeni u radu, ako bude prihvaćen za objavljivanje. ORCID je jedinstven i trajan identifikator koji omogućava preciznu identifikaciju autora i lakše pronalaženje objavljenih radova, kao i ispravnu atribuciju autorstva.

* * *

Predavanjem rukopisa redakciji *Arheologija i prirodne nauke* autori se obavezuju na poštovanje navedenih obaveza.

OBAVEZE RECENZENATA

Recenzenti su dužni da stručno, argumentovano, nepristrasno i u zadatim rokovima dostave uredniku ocenu naučne vrednosti rukopisa.

Recenzenti evaluiraju rukopise u odnosu na usklađenost teme rukopisa sa profilom časopisa; način ukazivanja na problem ili cilj istraživanja; doprinos disciplini kojoj pripada; jasnoću i konciznost apstrakta; organizaciju teksta; doslednost istraživačke metodologije; jasnoću i produktivnost diskusije; razvijanje zaključaka; relevantnost upotrebljene i citirane literature; jedinstvenost i preciznost stila izlaganja i naučnog aparata; kao i kvalitet priloga.

Recenzent koji ima osnovane sumnje ili saznanja o kršenju etičkih standarda od strane autora dužan je da o tome obavesti urednika. Recenzent treba da prepozna važne objavljene rukopise koje autori nisu citirali. On treba da upozori urednika i na bitne sličnosti i podudarnosti između rukopisa

koji se razmatra i bilo kojeg drugog objavljenog rukopisa ili rukopisa koji je u postupku recenzije u nekom drugom časopisu, ako o tome ima lična saznanja. Ako ima saznanja da se isti rukopis razmatra u više časopisa u isto vreme, recenzent je dužan da o tome obavesti urednika.

Recenzent ne sme da bude u sukobu interesa sa autorima i/ili finansijerom istraživanja. Ukoliko postoji sukob interesa, recenzent je dužan da o tome momentalno obavesti urednika.

Recenzent koji sebe smatra nekompetentnim za temu ili oblast kojom se rukopis bavi dužan je da o tome obavesti urednika.

Recenzija mora biti objektivna. Komentari koji se tiču ličnosti autora smatraju se neprimerenim. Sud recenzenata mora biti jasan i potkrepljen argumentima.

Rukopisi koji su poslani recenzentu smatraju se poverljivim dokumentima. Recenzenti ne smeju da koriste neobjavljen materijal iz predatih rukopisa za svoja istraživanja bez izričite pisane dozvole autora, a informacije i ideje iznesene u predatim rukopisima moraju se čuvati kao poverljive i ne smeju se koristiti za sticanje lične koristi.

POSTUPAK RECENZIJE

Svi primljeni rukopisi podležu recenziji. Cilj recenzije je da redakciji pomogne u donošenju odluke o tome da li rad treba prihvatiti ili odbiti i da kroz proces komunikacije sa autorima poboljša kvalitet rukopisa.

Svaki rukopis predat redakciji časopisa *Arheologija i prirodne nauke* dobija po dva recenzenta. Recenzenti mogu biti saradnici Arheološkog instituta ili spoljni saradnici, kompetentni u oblasti kojom se rukopis bavi. Predlog recenzenata daje redakcija, a usvaja glavni i odgovorni urednik.

Rukopisi se recenziraju po sistemu *double-blind*, koji podrazumeva anonimnu recenziju: identitet autora je nepoznat recenzentima i obrnuto.

Recenzent je dužan da recenziju pošalje redakciji najkasnije u roku od 30 dana nakon prijema rukopisa. Recenzenti za svoj rukopis ne dobijaju honorare.

Ukoliko recenzenti traže izmene u rukopisu, autori su dužni da u roku od 30 dana redakciji vrate izmenjen rukopis, ili ukoliko ne izmene, dostave argumentovano obrazloženje zašto izmena nije učinjena. Isto važi i za rukopise koji nisu

pripremljeni u skladu sa UPUTSTVOM ZA AUTORE.

Odluku o prihvatanju rukopisa za štampu donosi redakcija časopisa *Arheologija i prirodne nauke* većinom glasova na predlog recenzenata, a u skladu sa izmenama na rukopisu koje su autori izvršili ili u skladu sa dostavljenim obrazloženjem.

Nakon konačnog formiranja sadržaja broja, rukopisi idu na lekturu, a potom se šalju grafičkom dizajneru koji treba da uradi prelom za štampu. Pre odlaska u štampu rade se još dve korekture u PDF formatu. Konačno odobrenje za štampanje časopisa *Arheologija i prirodne nauke* daje glavni i odgovorni urednik. Rukopis celog broja u štampariji treba da bude 20. decembra tekuće godine.

Predloženi recenzenti od strane redakcije, dobijaju recenzentski obrazac koji sadrži niz pitanja na koja treba odgovoriti, a koja recenzentima ukazuju koji su to aspekti koje treba obuhvatiti kako bi se donela odluka o sudbini jednog rukopisa. Nakon toga, odlučuju se za jednu od četiri opcije: prihvatanje rada u obliku u kome je predat; prihvatanje rada nakon revizije manjeg obima; potreba revizije većeg obima; ili odbijanje rada. U završnom delu obrasca, recenzenti navode svoja zapažanja i predloge kako da se podneti rukopis poboljša. Identitet recenzenata ostaje nepoznat autorima pre, tokom i nakon postupka recenzije. Identitet autora je nepoznat recenzentima pre, tokom i nakon postupka recenzije (dok se rad ne objavi). Autorima se preporučuje da prilikom pisanja rukopisa izbegavaju formulacije koje bi mogle otkriti njihov identitet. Redakcija garantuje da će pre slanja rukopisa na recenziju iz njega biti uklonjeni lični podaci autora (pre svega, ime i afilijacija) i da će se preduzeti sve razumne mere kako bi identitet autora ostao nepoznat recenzentima do okončanja postupka recenzije.

Izbor recenzenata spada u diskreciona prava redakcije. Recenzenti moraju da raspolažu relevantnim znanjima u vezi sa oblašću kojom se rukopis bavi i poželjno je da to ne budu autori koji su u skorije vreme objavljivali publikacije zajedno (kao koautori) sa bilo kojim od autora podnesenog rukopisa.

Tokom čitavog procesa, recenzenti deluju nezavisno jedni od drugih. Recenzentima nije poznat identitet drugih recenzenata. Ako odluke recenzenata nisu iste (prihvatiti / odbiti), glavni i

odgovorni urednik može da traži mišljenje drugih recenzenata.

Tokom postupka recenzije urednici mogu da zahtevaju od autora da dostave dodatne informacije (uključujući i primarne podatke), ako su one potrebne za donošenje suda o naučnom doprinosu rukopisa. Urednici i recenzenti moraju da čuvaju takve informacije kao poverljive i ne smeju ih koristiti za sticanje lične koristi.

Redakcija je dužna da obezbedi kontrolu kvaliteta recenzije. U slučaju da autori imaju ozbiljne i osnovane zamerke na račun recenzije, redakcija će proveriti da li je recenzija objektivna i da li zadovoljava akademske standarde. Ako se pojavi sumnja u objektivnost ili kvalitet recenzije, urednik će tražiti mišljenje drugih recenzenata.

Članovi redakcije i gostujući urednici mogu da šalju svoje rukopise za objavljivanje u časopisu *Arheologija i prirodne nauke*. Autor rukopisa koji je uključen u izdavački proces biće izuzet iz postupka recenzije i odlučivanja o prihvatanju ili neprihvatanju rukopisa, a nadgledanje postupka recenzije biće povereno drugom članu redakcije.

DISKUSIJA NAKON OBJAVLJIVANJA RADA

Časopis *Arheologija i prirodne nauke* podstiče diskusiju nakon objavljivanja, bilo kroz pisma glavnom i odgovornom uredniku ili na spoljnim platformama, kao što je PubPeer.

UPOTREBA VELIKIH JEZIČKIH MODELA I GENERATIVNE VEŠTAČKE INTELIGENCIJE

Časopis *Arheologija i prirodne nauke* postupa u skladu sa sledećim preporukama: World Association of Medical Editors (WAME) recommendations on chat bots, ChatGPT and scholarly manuscripts i Committee on Publication Ethics (COPE)'s position statement on Authorship and AI tools.

Alati kao što je ChatGPT ne mogu biti navedeni kao autori rukopisa.

Autori moraju jasno da navedu da li su koristili alate zasnovane na velikim jezičkim modelima i generativnoj veštačkoj inteligenciji (koje alate su koristili i u koje svrhe) na odgovarajućem mestu,

kao što su odeljak u kom se opisuje metodologija ili zahvalnica.

Autori snose punu odgovornost za preciznost, tačnost i primerenost sadržaja generisanih uz pomoć alata zasnovanih na velikim jezičkim modelima i generativnoj veštačkoj inteligenciji, kao i za tačnost citiranih referenci, i garantuju da u rukopisu nema plagijarizma.

Glavni i odgovorni urednik, urednici i recenzenti moraju da garantuju da će informacije iznesene u rukopisima tokom postupka recenzije biti čuvane kao poverljive. Urednici ne smeju da dele informacije o poslatim rukopisima i izveštaje recenzenata sa alatima zasnovanim na velikim jezičkim modelima i generativnoj veštačkoj inteligenciji, a recenzenti ne smeju da koriste takve alate za generisanje recenzentskih izveštaja.

RAZREŠAVANJE SPORNIH SITUACIJA

Svaki pojedinac ili institucija mogu u bilo kom trenutku da glavnom i odgovornom uredniku, urednicima i/ili članovima redakcije prijave saznanja o kršenju etičkih standarda i drugim nepravilnostima i da o tome dostave neophodne informacije/dokaze.

Provera iznesenih navoda i dokaza

- Glavni i odgovorni urednik će u dogovoru sa urednicima i članovima redakcije odlučiti o pokretanju postupka koji ima za cilj proveru iznesenih navoda i dokaza.
- Tokom tog postupka svi izneseni dokazi smatraće se poverljivim materijalom i biće predloženi samo onim licima koja su direktno uključena u postupak.
- Licima za koja se sumnja da su prekršila etičke standarde biće data mogućnost da odgovore na optužbe iznesene protiv njih.
- Ako se ustanovi da je zaista došlo do nepravilnosti, proceniće se da li ih treba okarakterisati ako manji prekršaj ili grubo kršenje etičkih standarda.

Manji prekršaj

Situacije okarakterisane kao manji prekršaj rešavaće se u direktnoj komunikaciji sa licima

koja su prekršaj učinila, bez uključivanja trećih lica, npr.:

- obaveštavanjem autora/recenzenata da je došlo do manjeg prekršaja koji je proistekao iz nerazumevanja ili pogrešne primene akademskih standarda;
- pismom upozorenja autoru/recenzentu koji je učinio manji prekršaj.

Grubo kršenje etičkih standarda

Odluke u vezi sa grubim kršenjem etičkih standarda donosi glavni i odgovorni urednik u saradnji sa urednicima i članovima redakcije i, ako je to potrebno, malom grupom stručnjaka. Mere koje će preduzeti mogu biti sledeće (i mogu se primenjivati pojedinačno ili istovremeno):

- objavljivanje saopštenja ili uvodnika u kom se opisuje slučaj kršenja etičkih standarda;
- slanje službenog obaveštenja rukovodiocima ili poslodavcima autora/recenzenata;
- povlačenje objavljenog rukopisa u skladu sa procedurom opisanom pod *Povlačenje već objavljenih rukopisa*;
- autorima će biti zabranjeno da tokom određenog perioda šalju rukopise u časopis;
- upoznavanje relevantnih stručnih organizacija ili nadležnih organa sa slučajem kako bi mogli da preduzmu odgovarajuće mere.

Prilikom razrešavanja spornih situacija redakcija časopisa se rukovodi smernicama i preporukama međunarodne organizacije *Committee on Publication Ethics – COPE*: <https://publicationethics.org/guidance/Flowcharts>.

POVLAČENJE VEĆ OBJAVLJENIH RADOVA

U slučaju kršenja prava izdavača, nosilaca autorskih prava ili autora, povrede profesionalnih etičkih kodeksa, tj. u slučaju slanja istog rukopisa u više časopisa u isto vreme, lažne tvrdnje o autorstvu, plagijata, autoplagijata, manipulacije po-

dacima u cilju prevare, neprijavljivanja korišćenja alata zasnovanih na velikim jezičkim modelima i generativnoj veštačkoj inteligenciji, nenamerne greške koju je autor prijavio (npr. greške nastale zbog pomešanih uzoraka ili korišćenja uređaja i opreme za koje je naknadno utvrđeno da su neispravni), objavljeni rad se mora opozvati. U nekim slučajevima, objavljeni rad se može opozvati i kako bi se ispravile naknadno uočene greške. Osnovni razlog za povlačenje rukopisa je ispravljanje greške u cilju očuvanja integriteta nauke, a ne kazna autora.

Prilikom opozivanja objavljenog rada navodi se razlog za opozivanje, kao i na čiji se zahtev rad opoziva. Standardi za razrešavanje situacija kada mora doći do povlačenja rukopisa definisani su od strane biblioteka i naučnih tela, a ista praksa je usvojena i od strane časopisa *Arheologija i prirodne nauke*: u elektronskoj verziji izvornog rukopisa (onog koji se povlači) uspostavlja se veza (HTML link) sa obaveštenjem o povlačenju. Povučeni rukopis se čuva u izvornoj formi, ali sa vodenim žigom na PDF dokumentu, na svakoj stranici, koji ukazuje da je rukopis povučen (RETRACTED).

ISTRAŽIVAČKI PODACI

Časopis podstiče autore da učine dostupnim istraživačke podatke koji potkrepljuju rezultate objavljene u rukopisu i/ili obogaćuju objavljeni rad, tako da podaci budu otvoreni u najvećoj mogućoj meri, odnosno da budu zatvoreni samo ako je to zaista neophodno. Časopis *Arheologija i prirodne nauke* prihvata prateće softverske aplikacije, slike visoke rezolucije, skupove podataka, zvučne ili video snimke, obimne priloge, tabele sa podacima i druge relevantne dodatke koje nije moguće uključiti u sam rad.

Autori deponuju relevantne podatke u repozitorijum koji je u skladu sa FAIR principima, a to može biti institucionalni, tematski ili repozitorijum opšte namene. Više informacija o pronalaženju adekvatnog repozitorijuma možete naći na adresi: <https://repositoryfinder.datacite.org/>. U repozitorijum treba deponovati i sve informacije koje bi bile neophodne za repliciranje, validaciju i/ili korišćenje rezultata, odnosno analizu podataka – informacije o softveru, instrumentima i drugim alatima koji se koriste za obradu rezultata.

Ako je moguće, treba deponovati i same alate i instrumente.

Izuzeci: Javno objavljivanje podataka nije uvek izvodljivo. U sledećim slučajevima podaci koji potkrepljuju rezultate objavljene u radovima ne moraju biti javno dostupni: ako postoji obaveza zaštite rezultata i poverljivosti, bezbednosna ograničenja, obaveza zaštite ličnih podataka i druga legitimna ograničenja. Kada podatke neophodne za validaciju objavljenih zaključaka nije moguće objaviti u otvorenom pristupu, autori bi trebalo da obezbede pristup u meri koja omogućava validaciju zaključaka uz poštovanje legitimnih interesa ili ograničenja.

ETIČKA PITANJA I ZAŠTITA PODATAKA

Ako je pristup podacima ograničen iz etičkih razloga ili zato što podaci moraju biti zaštićeni, u rukopisu se mora navesti: opis ograničenja koja se odnose na podatke; stav etičkog odbora ili drugog nadležnog tela o objavljivanju podataka; i na koji način čitaoci ili recenzenti mogu da zatraže pristup podacima i uslove pod kojima će pristup biti odobren.

Zaštita podataka

U cilju zaštite privatnosti ispitanika, istraživački podaci se ne smeju objavljivati ako iz skupa podataka nije moguće efikasno ukloniti informacije o ličnosti na osnovu kojih se mogu identifikovati konkretni pojedinci, osim ako pojedinci nisu dali izričitu pisanu saglasnost za javno objavljivanje podataka koji sadrže informacije o ličnosti.

Ako podaci ne mogu da budu javno dostupni, rukopis rada mora da sadrži: obrazloženje zašto je neophodna zaštita podataka; povezane podatke iz kojih je moguće ukloniti informacije o ličnosti; stav etičkog odbora ili drugog nadležnog tela o objavljivanju podataka; i na koji način čitaoci ili recenzenti mogu da zatraže pristup podacima i uslove pod kojima će pristup biti odobren.

Pored toga, adrese na kojima se nalaze podaci treba navesti u *Izjavi o dostupnosti podataka u okviru dostavljenog rukopisa*. Ako podaci nisu dostupni, u izjavi treba objasniti zašto nisu dostupni. Kada deponujete podatke koji su u vezi sa

rukopisom poslatim za objavljivanje, u obzir treba uzeti sledeće:

Repozitorijum u koji se podaci deponuju mora biti odgovarajući u tematskom smislu i mora biti održiv. Podaci se moraju deponovati pod slobodnom licencom koja dozvoljava neograničen pristup (npr. CC0, CC-BY). Restriktivnije licence treba koristiti samo ako postoji opravdan (npr. pravni) razlog. Deponovani podaci moraju da sadrže i verziju koja je u otvorenom, ne vlasničkom formatu. Deponovani podaci moraju biti obeleženi tako da na takav način da ih treća strana može shvatiti (npr. razumna zaglavlja kolona, opisi u tekstualnoj datoteci readme).

Istraživanja koja uključuju ljudske subjekte, istraživanja na humanom materijalu, i podatke o ljudskim subjektima moraju se obavljati u skladu sa Helsinškom deklaracijom. U određenim slučajevima studije moraju imati odobrenje odgovarajućeg Etičkog komiteta. Identitet subjekta istraživanja treba da bude anonimizovan kad god je to moguće. Za istraživanje koje uključuje ljudske subjekte, neophodan je informisani pristanak učesnika (ili njihovih zakonskih staratelja) za učešće u istraživanju.

Rukopis koji se šalje za objavljivanje treba da sadrži *Izjavu o dostupnosti podataka*, ispred spiska referenci. U njoj se navode podaci o dostupnosti podataka, uključujući DOI oznaku podataka. Ako su je pristup podacima na bilo koji način ograničen, treba obrazložiti zašto je do toga došlo.

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AUTORSKA PRAVA

Kada je rukopis prihvaćen za objavljivanje, autori prenose autorska prava na izdavača.

Na izdavača se prenose sledeća prava na rukopis, uključujući i dodatne materijale, i sve delove, izvode ili elemente rukopisa:

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* * *

Model politike je razvio EIFL inspirisan sledećim dokumentima:

Principles of transparency and best practice in scholarly publishing. Directory of Open Access Journals. <https://doaj.org/apply/transparency/> (accessed 2023-01-06).

Core practices. COPE: Committee on Publication Ethics. <https://publicationethics.org/core-practices> (accessed 2022-12-10).

Policies. Open Research Europe. <https://open-research-europe.ec.europa.eu/about/policies> (accessed 2022-11-08).

Journal Policies. Glossa: a journal of general linguistics. <https://www.glossa-journal.org/site/journal-policies/> (accessed 2023-01-06).

* * *

Ova Uređivačka politika se primenjuje od sledećeg broja časopisa *Arheologija i prirodne nauke* (*Archaeology and Science*).

UPUTSTVO AUTORIMA

O NAČINU PRIPREME RUKOPISA

ZA ČASOPIS *ARHEOLOGIJA I PRIRODNE NAUKE*

Redakcija časopisa *Arheologija i prirodne nauke* odlučila je da primenom važećeg pravilnika Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije, kojim se uređuje opremanje naučnih časopisa u celini, unapredi kvalitet časopisa i na taj način doprinese njegovom potpunijem uključivanju u međunarodni sistem razmene naučnih informacija.

Časopis *Arheologija i prirodne nauke* posvećen je temama iz humanističkih naučnih disciplina: arheologije, istorije, klasične filologije, istorije umetnosti i arhitekture, socijalne i kulturne antropologije; temama iz multidisciplinarnih istraživanja koja povezuju arheologiju i prirodne nauke: fizičke (bio) antropologije, arheometrije, geonauka u arheologiji, tehnologija u arheološkoj prospekcijskoj; temama koje se bave zaštitom i prezentacijom arheološkog nasleđa: konzervacijom i restauracijom kulturnog nasleđa, eksperimentalnom arheologijom, interpretacijom arheološkog nasleđa, digitalnom arheologijom, kompjuterskim i informacionim tehnologijama i arheološkom dokumentacijom; i drugim temama povezanim sa arheologijom.

Časopis *Arheologija i prirodne nauke* objavljuje originalne, prethodno neobjavljene rukopise: istraživačke radove, pregledne radove, izveštaje, metodološke radove, studije slučaja i prikaze.

Jezici na kojima se mogu predati rukopisi su engleski (standardni britanski), nemački ili francuski. Rezime mora biti na srpskom jeziku - latinica (za domaće autore) ili engleskom jeziku (za inostrane autore).

Rukopisi koji se predaju redakciji časopisa *Arheologija i prirodne nauke* moraju biti opremljeni na standardni način. Svaki tekst koji se predaje treba da sadrži: naslov; ime autora; naziv ustanove (afilijacija); apstrakt; ključne reči; osnovni tekst; rezime; grafičke i numeričke

priloge sa popisom (ilustracija, crteža, dijagrama i tabela); bibliografiju; kontakt podatke.

1. Naslov treba da bude kratak i jasan, i da što vernije opiše sadržaj rukopisa. Poželjno je da sadrži 10-12 reči (maksimalna dužina naslova je 20 reči). U naslovu treba da se koriste reči prikladne za indeksiranje i pretraživanje. Ako takvih reči nema u naslovu, poželjno je da se naslovu pridoda podnaslov. Naslov se piše u petom ili šestom redu ispod gornje margine velikim masnim (bold) slovima veličine 14.
2. Autor ili autori rukopisa treba da navedu svoje puno ime i prezime i srednje slovo (ako ga autor koristi), velikim slovima veličine 12.
3. Autor ili autori treba da navedu zvaničan naziv i sedište ustanove u kojoj su zaposleni, a eventualno naziv i sedište ustanove u kojoj su obavili istraživanja čije rezultate sada objavljuju. Kod složenih institucija navodi se ukupan naziv (npr.: Univerzitet u Beogradu, Filozofski fakultet, Odeljenje za arheologiju, Beograd, Srbija). Navod se piše slovima veličine 12.
4. Apstrakt je kratak prikaz sadržaja rukopisa (100-250 reči). Piše se kurzivom (italic) veličine 12. Poželjno je da sadrži termine koji se često koriste za indeksiranje i pretraživanje rukopisa. Apstrakt treba da pruži podatke o cilju istraživanja, metodama, rezultatima istraživanja i zaključku. U apstraktu ne treba navoditi reference.
5. Ključne reči treba da budu termini koji najbolje opisuju sadržaj rukopisa za potrebe indeksiranja i pretraživanja.

- Treba ih navoditi na osnovu nekog međunarodnog izvora (popisa, rečnika, tezaurusa) koji je najšire prihvaćen, kao što je lista ključnih reči Web of Science. Broj ključnih reči ne treba da bude veći od 10. Pišu se velikim masnim (bold) slovima veličine 9.
6. Tekst rukopisa ne bi trebalo da prelazi dva autorska tabaka (32 strane), u formatu A4, odnosno 60.000 slovnih znakova (karaktera) sa razmakom, uključujući: osnovni tekst sa naslovom, podnaslovima, međunaslovima, napomenama i formulama; potpise ispod ilustracija, crteža, dijagrama i tabela, bibliografiju i ostale delove teksta. Tekst treba uraditi kompjuterski u fontu Times New Roman ili Arial (12), MS Office Word 97 ili novijim (formati .doc ili .docx), sa proredom 1,5 i marginama 2,54 cm. Osnovni tekst ne sme da sadrži grafičke i numeričke priloge (ilustracije, crteže, dijagrame, tabele), već se one predaju kao posebni fajlovi.
 7. Reči, navodi i naslovi pisani na nekom od stranih jezika treba da budu napisani u svom izvornom obliku.
 8. Osnovni tekst mora sadržati *Uvod* i *Zaključak*. Ostala poglavlja imenuje autor. Napomene (fusnote) mogu biti sastavni deo osnovnog teksta. Treba da sadrže manje važne podatke ili odgovarajuća objašnjenja. One nisu zamena za citiranu literaturu. (Poseban odeljak ovog Uputstva govori o načinu citiranja koji treba primenjivati prilikom pisanja tekstova).
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Način navođenja u bibliografiji:

Popović, I. 2009

Gilt Fibula with Christogram from Imperial Palace in Sirmium (Резиме: Позлаћена фибула са христограмом из царске палате у Сирмијуму), *Starinar* LVII (2007): 101–112.

Publikacije štampane ćiriličnim, grčkim ili bilo kojim drugim nelatiničnim pismom, transkribuju se na latinicu u skladu sa standardima Američkog bibliotečkog društva i Kongresne biblioteke SAD (<http://www.loc.gov/catdir/cpsd/roman.html>), npr:

Citat u tekstu: (Поповић 1988: 67)

Način navođenja u bibliografiji:

Поповић, И. 1988

Античко оруђе од гвожђа у Србију,

Београд: Народни музеј.
(Popović, I. 1988

Antičko oruđe od gvožđa u Srbiji, Beograd: Narodni muzej).

12. Sastavni delovi bibliografskih jedinica (autorska imena, naslov rada, izvor itd.) navode se u skladu sa usvojenom formom navođenja. Redakcija časopisa *Arheologija i prirodne nauke* prihvatila je preporuku Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije i odlučila da autori treba dosledno da primenjuju pravila citiranja i navođenja literature prema uzoru na sistem koji navodimo u daljem delu teksta.

U primerima koji slede navedene su najčeće citirane vrste referenci:

I KNJIGE (MONOGRAFIJE)

1. Autorizovane knjige

a. jedan autor

u tekstu: (Popović 2006)

u Literaturi:

Prezime, Inicijal imena. Godina

Naslov monografije (u kurzivu), Mesto izdanja: Izdavač.

Popović, I. 2006

Roma aeterna inter Savum et Danubium, Works of Roman Art from the Petrović-Vasić Collection, Belgrade: Archaeological Institute.

- Potrebno je navesti i naziv serije i broj:

Mirković, M. 1968

Rimski gradovi na Dunavu u Gornjoj Mezi, Dissertationes 6, Beograd: Arheološko društvo Jugoslavije.

Papazoglu, F. 1969

Srednjobalkanska plemena u predrimsko doba (Tribali, Autarijati, Dardanci, Skordisci i Mezi), Djela 30, Centar za balkanološka ispitivanja 1, Sarajevo: Akademija nauka i umjetnosti Bosne i Hercegovine.

b. dva ili tri autora

Između imena prvog i drugog autora, ili drugog i trećeg u bibliografskoj jedinici na srpskom jeziku treba da stoji veznik **i** (ćirilicnim pismom, ako je bibliografska jedinica na ćirilici, a latiničnim, ako je na latinici). Ako je rad naveden u literaturi na engleskom ili nekom drugom stranom jeziku, treba da stoji (bez obzira na korišćeni jezik) engleski veznik **and**.

u tekstu: (Popović i Borić-Brešković 1994: 16–18)

u Literaturi:

Popović, I. i Borić-Brešković B. 1994

Ostava iz Bele Reke, Arheološke monografije 7, Beograd: Narodni muzej.

Ivanišević, V., Kazanski, M. and Mastykova, A. 2006

Les necropoles de Viminacium a l'Epoque des Grandes Migrations, Monographies 22, Paris: Association des Amis du Centre d'Histoire et Civilisation de Byzance.

c. četiri i više autora

Za knjige štampane na srpskom jeziku ćirilicom koje imaju četiri i više autora, navodi se samo ime prvog autora i dodaje se u nastavku **и др.**; kod latinice se koristi **i dr.** Za knjige štampane latinicom u bilo kom drugom jeziku koristi se u nastavku skraćenica **et al.** Skraćenica **etc.** koristi se u slučajevima kada ima više od tri suizdavača ili mesta izdanja.

2. Autorizovane knjige sa pridodatim imenom urednika

u tekstu: (Jeremić 2009: 40)

u Literaturi:

Jeremić, G. 2009

Saldum, Roman and Early Byzantine Fortification, ed. S. Perić, Cahiers des Portes de Fer, Monographies 6, Belgrade: Institute of Archaeology.

3. Priredene knjige (umesto autora - urednik, priređivač, prevodilac) - (ur.), (ed., eds.), (prev.).

u tekstu: (Поповић 1994)

u Literaturi:

Поповић, И. (ur.) 1994

Античко сребро у Србији, Београд:

Народни музеј.

u tekstu: (Morris 2002)

u Literaturi:

Morris, I. (ed.) 2002

Classical Greece-Ancient Histories and Modern Archaeologies, Cambridge: Cambridge University Press.

u tekstu: (Hurst and Owen 2005)

u Literaturi:

Hurst, H. and Owen. S.(eds.) 2005

Ancient Colonizations-Analogy, Similarity and Difference, London: Duckworth.

u tekstu: (Радојчић 1960)

u Literaturi:

Радојчић, Н. (prev.) 1960

Законик цара Стефана Душана 1349. и 1354, Београд: Српска академија наука и уметности.

4. *Knjiga bez naznačenog autora*

u tekstu: (Anon. 1985)

u Literaturi:

Anon. 1985

Anonymi Peri strategias, The Anonymous Byzantine Treatise on Strategy, *Three Byzantine Military Treatise* (trans. G.T. Dennis), Washington DC.

5. *Istovremeno citiranje i navođenje više knjiga istog autora*

a. pisanih različitim pismom

u tekstu: (Поповић 2002: 23-26; Поповић 2006: 33)

u Literaturi:

Поповић, И. 2002

Накит са Јухора, остава или сакрални тезаурус, Археолошке монографије 14, Посебна издања 36, Београд: Народни музеј и Археолошки институт.

Popović, I. 2006

Roma Aeterna inter Savum et Danubium, Works of Roman Art from the Petrović-Vasić Collection, Belgrade: Archaeological Institute.

b. pisanih iste godine

u tekstu: (Dawkins 1996a; Dawkins 1996b)

u Literaturi:

Dawkins, R. 1996a

Climbing Mount Improbable, London: Viking.

Dawkins, R. 1996b

River out of Eden, London: Pfoenix.

6. *Citiranje i navođenja poglavlja i odeljka u knjizi (zborniku radova)*

u tekstu: (Петровић 1997: 87–90)

u Literaturi:

Петровић, Б. 1997

Накит, у: *Античка бронза Сингидунума*, С. Крунић (ур.), Београд: Музеј града, 85–117.

u tekstu: (Samson 1970: 44–68)

u Literaturi:

Samson, C. 1970

Problems of information studies in history, in: *Humanities information research*, S. Stone, (ed.), Sheffield: CRUS, 44–68.

7. *Prevedene knjige*

u Literaturi:

Bajron, Dž. G. 2005 (1812)

Čajld Harold, predgovor Z. Paunović, prevod i predgovor N. Tučev, Београд: Zavod za udžbenike i nastavna sredstva.

8. *Knjige i članci objavljeni u elektronskom obliku*

u tekstu: (Fishman 2005: 11)

u Literaturi:

Fishman, R. 2005

The rise and fall of suburbia, [e-book], Chester: Castle Press. Available through Anglia Ruskin University Library, <http://libweb.anglia.ac.uk> (accessed on June 5th 2005).

II RADOVI OBJAVLJENI U ZBORNICIMA, AKTIMA KONGRESA I SLIČNO

Prezime, Inicijal imena. Godina

Naslov rada, u: *Naslov zbornika (kurziv)*, Inicijal imena. Prezime (ur.), Mesto izdanja: Izdavač, broj strana.

Брукнер, О. 1987

Импортована и панонска керамичка продукција са аспекта друштвено-економских промена, у: *Почеци романизације у југоисточном делу провинције Паноније*, М. Стојанов (ур.), Нови Сад: Матица српска, 25–44.

Potrebno је navesti i podatke o seriji:

Петровић, П. 1997

Римљани на Тимоку, у: *Археологија источне Србије* (Научни скуп Археологија источне Србије, Београд-Доњи Милановац, децембар 1995), М. Лазић (ур.), Центар за археолошка истраживања 18, Београд: Филозофски факултет, 115–131.

III PERIODIKA

Prezime, Inicijal imena. Godina

Naslov rada, Naziv časopisa (kurziv) broj časopisa: broj strane.

Бајаловић-Хади-Пешић, М. 2001

Налази хабанске и постхабанске керамике у Србији, *Годишњак града Београда* 47–48 (2000-2001): 107–121.

- За часописе чији су називи слични, иза назива часописа у загради треба navesti место izdanja:

Анђелковић, Б. 1988

Праисторијски налази са локалитета Јелица-Градина, *Зборник радова Народног музеја* (Чачак) 18: 81–85.

Анђелковић, Б. 1994

Први резултати анализе мумије из Народног музеја у Београду, *Зборник Народног музеја* (Београд) 15-1: 153–159.

- *Старинар* се, зависно од године izdanja, navodi punim nazivom:

godine 1884-1895 *Старинар Српског археолошког друштва*

godine 1906-1914 [novog reda] *Старинар* (н.р.)

godine 1922-1942 [treća serija] *Старинар* (т.с.)

godine 1950-2010 [nova serija] *Старинар* (т.с.)

- Ukoliko се година izlaženja i година за коју часопис излази razlikuju, navesti i drugu

godinu u zaгради:

Жеравица, З., и Жеравица, Л. 1979

Средњовековно насеље у Поповици код

Неготина, *Старинар* (н.с.) 28-29 (1977-1978): 201–211.

Rad u štampi / u pripremi

- u štampi, u tekstu (in print)

- u pripremi, u tekstu (forthcoming).

u tekstu: (Јовановић, in print)

u literaturi:

Јовановић, А. (in print)

Бор и околина у античком периоду, у: *Бор и околина у праисторији, антици и средњем веку*, М. Лазић (ур.), Бор: Музеј рударства и металургије; Београд: Филозофски факултет.

IV ČLANCI IZ ELEKTRONSKIH ČASOPISA

Članci preuzeti sa interneta iz elektronskih časopisa navode се na isti način kao štampani članci, ali се na kraju dodaje puna veb adresa sa <http://...>

V DOKTORSKE DISERTACIJE I MAGISTARSKE TEZE

Umesto mesta izdanja i izdavača navodi се naziv fakulteta/univerziteta gde је teza odbran-jena.

u literaturi:

Ilić, O. 2005

Ranohrišćanski pokretni nalazi na području dijeceze Dakije od IV do početka VII veka, Magistarski rad, Filozofski fakultet, Univerzitet u Beogradu.

Patch, D. C. 1991

The Origin and Early Development of Urbanism in Ancient Egypt: A regional Study, Ph.D Thesis, University of Pennsylvania.

VI POPULARNI MAGAZINI/ ČASOPISI I NOVINSKI ČLANCI

u tekstu: Кашанин, М. 1929

u literaturi:

Кашанин, М. 1929

Музеј савремене уметности, *Политика*, 23. јул, 7–8.

13. Sve reference citirane u tekstu navode se po abecednom redosledu inicijala u prezimenu autora ili početnog slova u nazivu dela (ako autor ili urednik nisu naznačeni).

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ARHEOLOGIJA I PRIRODNE NAUKE

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The journal *Arheologija i prirodne nauke* (*Archaeology and Science*) is dedicated to the topics in the humanistic scientific disciplines: archaeology, history, classical philology, history of art and architecture, social and cultural anthropology; the topics from multidisciplinary research that connect archaeology and sciences: physical (biological) anthropology, archaeological science, geosciences in archaeology, technologies in archaeological survey; the topics dealing with protection and presentation of archaeological heritage: conservation and restoration of cultural heritage, experimental archaeology, interpretation of archaeological heritage, digital archaeology, computing and information technologies and archaeological documentation; and other topics connected to archaeology.

The journal *Arheologija i prirodne nauke* (*Archaeology and Science*) has been published from 2006 as a periodical publication issued by the Institute of Archaeology, Belgrade and the Centre for New Technology Viminacium.

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Core practices. COPE: Committee on Publication Ethics. <https://publicationethics.org/core-practices> (accessed 2022-12-10).

Policies. Open Research Europe. <https://open-research-europe.ec.europa.eu/about/policies> (accessed 2022-11-08).

Journal Policies. Glossa: a journal of general linguistics. <https://www.glossa-journal.org/site/journal-policies/> (accessed 2023-01-06).

* * *

This Editorial Policy applies from the next issue of the journal *Arheologija i prirodne nauke* (*Archaeology and Science*).

SUBMISSION INSTRUCTIONS

FOR THE JOURNAL *ARHEOLOGIJA I PRIRODNE NAUKE* (*ARCHAEOLOGY AND SCIENCE*)

Editorial Board of the periodical *Arheologija i prirodne nauke* (*Archaeology and Science*) decided to apply the current rulebook issued by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia. By applying these acts, complete editing of scientific periodicals is determined, quality of periodicals is promoted and their integration into the international system of exchanging academic information shall become more complete.

The journal *Arheologija i prirodne nauke* (*Archaeology and Science*) is dedicated to the topics in the humanistic scientific disciplines: archaeology, history, classical philology, history of art and architecture, social and cultural anthropology; the topics from multidisciplinary research that connect archaeology and sciences: physical (biological) anthropology, archaeological science, geosciences in archaeology, technologies in archaeological survey; the topics dealing with protection and presentation of archaeological heritage: conservation and restoration of cultural heritage, experimental archaeology, interpretation of archaeological heritage, digital archaeology, computing and information technologies and archaeological documentation; and other topics connected to archaeology.

The journal *Arheologija i prirodne nauke* (*Archaeology and Science*) publishes original manuscripts that have not been published previously: research articles, review articles, report articles, methodology articles, case study articles and book (or other publication) reviews.

Manuscripts can be submitted in English (standard British), German or French. The summary needs to be in Serbian-Latin (for authors from Serbia) or in English (for international authors).

Manuscripts submitted to the Editorial Board of the periodical *Arheologija i prirodne nauke* (*Archaeology and Science*) must be formed in a standard way. Each manuscript submitted has to contain: title; author's name; name of the institution (affiliation); abstract; key words; main text; resume; figures and tables with captions; bibliography; contact address.

1. Titles need to be short and clear, describing content in the best possible way. The preferred length of the title is 10-12 words (maximum length is 20 words). Words used in titles should be appropriate for indexing and web-searching. If there are no such words within titles, it is advised to add a subtitle. Titles are to be written in the fifth or sixth line, under the top margin, in capitals, bold and with font size 14.
2. Author(s) should give their full name(s), including first name, middle name (if used), and surname, in capitals, font size 12.
3. Author(s) need to state official names and addresses of their employees, including names and addresses of institutions in which the research was conducted, that led to the publication of results. With complex institutions, complete title is to be named (ex.: University Belgrade, Faculty of Philosophy, Department of Archaeology, Belgrade, Serbia). It should be written with font size 12.
4. Abstract, consisting of 100-250 words, describes shortly content of the manuscript. It should be written in italics, font size 12. Within abstracts, it is advised to use terms convenient for

- indexing and web-searching. Abstracts should offer data about aims, methods, results and conclusions of the research. Please, do not include citations in the Abstract
 5. Key words need to be terms which describe manuscript 's content in a best way, suitable for indexing and web-searching. They should be named according to a widely accepted international source (lists, indexes, dictionary, thesaurus), like list of key-words Web of Science. The number of key-words should not exceed ten words. The key words should be written as capitals, bold, with font size 9.
 6. The length of manuscripts should not exceed 32 pages, DIN A4, that is, 60,000 characters with spaces, including the main text with title and subtitles, footnotes and formulas; figure and table captions, bibliography, and other textual elements of the manuscript. The main text should be written in Times New Roman or Arial (12), MS Office Word 97 or later (.doc or .docx format), line-spacing 1,5 and with margins 2,54 cm. Main text should not contain figures and tables. They are to be submitted as separate files.
 7. Words, quotations and titles written in some other language should be written in their original form.
 8. Main text must contain *Introduction* and *Conclusion*. Other chapters are named by the author(s). Footnotes can be incorporated within the main text. They should contain less important data or appropriate explanations. They are not to be replaced with quoted literature. (Separate section of these Instructions explains the way of quoting to be applied).
 9. The summary must have the same content as the abstract, only expanded, but not longer than 1/10 of the manuscript's overall size, as well as the title of the manuscript. It is strongly advised to write the summary in a structural form. The summary needs to be in Serbian (for authors from Serbia) or in English (for international authors).
 10. Figures (photographs, drawings, diagrams) and tables should be submitted in a proposed manner. Scanned illustrations should be submitted in a 600 dpi resolution, while photographs are to be submitted in a resolution of at least 300 dpi, in formats TIFF, PSD or JPG. Figures and tables are to be submitted as separate files and should not be incorporated into the main text.
 11. The bibliography should include bibliographic sources (articles, monographs etc.). Within the manuscript it should be quoted with references in the text and as a list of literature/bibliography in a separate document. The bibliography represents a part of every scientific manuscript, with precisely quoted bibliographical references. The list of used sources should follow a unique pattern, in a sequence based on the quoting standards determined by these instructions. The bibliography must be presented in the language and alphabet in which each source has been published. In cases when the publication is published bilingually, all data should also be written bilingually.
- In the list of references:
- Popović, I. 2009**
Gilt Fibula with Christogram from the Imperial Palace in Sirmium (Резиме: Позлаћена фибула са христограмом из царске палате у Сирмијуму), *Starinar* LVII (2007): 101–112.
- Publications published in Cyrillic, Greek or any other non Latin alphabet should be transliterated into the Latin alphabet in accordance with the standards of The American Library Association and The Library of Congress of the United States (<http://www.loc.gov/catdir/cpsd/roman.html>), for example:
- Quotation within a footnote: (Поповић 1988: 67)
- In the list of references: **Поповић, И. 1988**
Античко оруђе од звожђа у Србији, Београд: Народни музеј.

(Popović, I. 1988

Antičko oruđe od gvožđa u Srbiji, Beograd: Narodni muzej).

12. Bibliography's structural elements (author's name, title of work, source etc.) should be written according to standard forms of quoting. Editorial Board of the periodical accepted the recommendation of the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, and decided that authors should precisely follow quotation rules named below.

The following examples describe the most frequently quoted kinds of references:

I BOOKS (MONOGRAPHS)

1. Author's books

a. single author

within main text: (Popović 2006)

in bibliography:

Surname, name's initial. Year of publishing

Title of book (italic), Place: Publisher.

Popović, I. 2006

Roma aeterna inter Savum et Danubium, Works of Roman Art from the Petrović-Vasić Collection, Belgrade: Archaeological Institute.

- Series' name and number is also needed:

Mirković, M. 1968

Rimski gradovi na Dunavu u Gornjoj Mezi, Dissertationes 6, Beograd: Arheološko društvo Jugoslavije.

Papazoglu, F. 1969

Srednjobalkanska plemena u predrimsko doba (Tribali, Autarijati, Dardanci, Skordisci i Mezi), Djela 30, Centar za balkanološka ispitivanja 1, Sarajevo: Akademija nauka i umjetnosti Bosne i Hercegovine.

b. two or three authors

Between the names of the first and second author, or the second and third in the bibliographic

reference in the Serbian language, there should be the conjunction (in Cyrillic script **и**, if the bibliographic unit is in Cyrillic, and in Latin **i**, if it is in Latin). If the work is cited in the literature in English or another foreign language, it should appear (regardless of the language used) the English conjunction **and**.

within main text: (Popović i Borić-Brešković 1994)

in bibliography:

Popović, I. i Borić-Brešković B. 1994

Ostava iz Bele Reke, Arheološke monografije 7, Beograd: Narodni muzej.

Ivanišević, V., Kazanski, M. and Mastykova, A. 2006

Les necropoles de Viminacium a l'Epoque des Grandes Migrations, Monographies 22, Paris: Association des Amis du Centre d'Histoire et Civilisation de Byzance.

c. four or more authors

Books written by four or more authors in Serbian, and in Cyrillic, only the first name is written and **и др.** is added; with the Latin alphabet, **i dr.** is used. For books printed in other languages, and in Latin alphabet, the abbreviation **et al.** is applied. The abbreviation **etc.** is used in cases when there are more than three editors or places of editing.

2. Author's books with added name of the editor

within main text: (Jeremić 2009: 40)

in bibliography:

Jeremić, G. 2009

Saldum, Roman and Early Byzantine Fortification, S. Perić (ed.), Cahiers des Portes de Fer, Monographies 6, Belgrade: Institute of Archaeology.

3. Edited books (instead of the author – editor, translator) - (ed., eds.), (trans.).

within main text: (Поповић 1994)

in bibliography:

Поповић, И. (ур.) 1994

Античко сребро у Србији, Београд: Народни музеј.

within main text: (Morris 2002)

in bibliography:
Morris, I. (ed.) 2002
Classical Greece-Ancient Histories and Modern Archaeologies, Cambridge: Cambridge University Press.

within main text: (Hurst and Owen 2005)
in bibliography:
Hurst, H. and Owen, S.(eds.) 2005
Ancient Colonizations-Analogy, Similarity and Difference, London: Duckworth.
within main text: (Радојчић 1960)
in bibliography:
Радојчић, Н. (prev.) 1960
Законик цара Стефана Душана 1349. и 1354., Београд: Српска академија наука и уметности.

4. Way of quoting books without author's name

within main text: (Anon. 1985)
in bibliography:
Anon. 1985
Anonymi Peri strategias, The Anonymous Byzantine Treatise on Strategy, *Three Byzantine Military Treatise* (trans. G.T. Dennis), Washington DC.

5. Simultaneous quoting of several books of the same author

a. written in different alphabets
within main text: (Поповић 2002: 23–26; Поповић 2006: 33)
in bibliography:
Поповић, И. 2002
Накит са Јухора, остава или сакрални тезаурус, Археолошке монографије 14, Посебна издања 36, Београд: Народни музеј и Археолошки институт.
Поповић, I. 2006
Roma Aeterna inter Savum et Danubium, Works of Roman Art from the Petrović-Vasić Collection, Belgrade: Archaeological Institute.

b. written in the same year
within main text: (Dawkins 1996a, Dawkins 1996b)
in bibliography:
Dawkins, R. 1996a

Climbing Mount Improbale, London: Viking.

Dawkins, R. 1996b
River out of Eden, London: Pfoenix.

6. Quoting chapters in books (acta)

within main text: (Петровић 1997: 87–90)
in bibliography:
Петровић, Б. 1997
Накит, у: *Античка бронза Сингидунума*, С. Крунић (ур.), Београд: Музеј града, 85–117.
within main text: (Samson 1970: 44–68)
in bibliography:
Samson, C. 1970
Problems of information studies in history, in: *Humanities information research*, S. Stone (ed.), Sheffield: CRUS, 44–68.

7. Translated books

in bibliography:
Bajron, DŽ. G. 2005 (1812)
Čajld Harold, Z. Paunović (predgovor), N. Tučev (prevod), Beograd: Zavod za udžbenike i nastavna sredstva.

8. Books and articles published in electronic form

within main text: (Fishman 2005: 11)
in bibliography:
Fishman, R. 2005
The rise and fall of suburbia, [e-book], Chester: Castle Press. Available through Anglia Ruskin University Library, <http://libweb.anglia.ac.uk/> (accessed on June 5th 2005).

II PAPERS PUBLISHED IN PERIODICALS, CONGRESS ACTA AND SIMILAR

within main text: (Vasić 2008: 69, fig.3)

in bibliography:
Surname, name's initial. Year
Title, in: *Title of the acta (italic)*, Name's initial. Surname (ed.), Place of publishing: Publisher, page numbers.

Vasić, M. 2006.

Stibadium in Romuliana and Mediana, in: *Felix Romvliana 50 years of archaeological excavations*, M. Vasić (ed.). October, 27-29 2003, Zaječar, Serbia. Belgrade: Institut of Archaeology, Committee on Archaeology of Serbian Academy of Sciences and Arts, and Zaječar: National Museum, 69–75.

Series' data are also needed:

Петровић, П. 1997

Римљани на Тимоку, у: *Археологија источне Србије* (Научни скуп Археологија источне Србије, Београд-Доњи Милановац, децембар 1995), М. Лазић (ур.), Центар за археолошка истраживања 18, Београд: Филозофски факултет, 115–131.

III PERIODICALS

within main text: (Бајаловић-Хаџи-Пешић, 2001: 108)

Surname, Name's initial. Year

Title, Name of the periodical (*italic*) number of the periodical: page number.

Бајаловић-Хаџи-Пешић, М. 2001

Налази хабанске и постхабанске керамике у Србији, *Годишњак града Београда* 47-48 (2000-2001): 107–121.

- For periodicals with similar titles, behind the name of the periodical, place of publishing should be stated in brackets:

Анђелковић, Б. 1988

Праисторијски налази са локалитета Јелица-Градина, *Зборник радова Народног музеја* (Чачак) 18: 81–85.

Анђелковић, Б. 1994

Први резултати анализе мумије из Народног музеја у Београду, *Зборник Народног музеја* (Београд) 15-1: 153–159.

- Depending on the year of publishing *Старинар* is named in its full title:

years 1884-1895 *Старинар*

Српског археолошког друштва

years 1906-1914 [novogreda] *Старинар*

(н.р.)

years 1922-1942 [treća serija] *Старинар*

(т.с.)

years 1950-2010 [nova serija] *Старинар*

(н.с.)

- If there is a difference between the year of actual printing and the year of publishing, the second is stated in brackets:

Жеравица, З., и Жеравица, Л. 1979, Средњовековно насеље у Поповици код Неготина, *Старинар* (н.с.) XXVIII-XXIX, (1977-1978): 201–211.

Paper in print / forthcoming

- in print, in the text (in print)

- forthcoming, in the text (forthcoming).

within main text: (Јовановић, in print)

in bibliography:

Јовановић, А. (in print)

Бор и околина у античком периоду, у: *Бор и околина у праисторији, антици и средњем веку*, М. Лазић (ур.), Бор: Музеј рударства и металургије; Београд: Филозофски факултет.

IV ARTICLES FROM ELECTRONIC PERIODICALS

Papers overtaken from the internet, from electronic periodicals, are quoted in the same way as printed papers, only there is a full web-address written at the end with http://...

V DOCTORAL AND MASTER THESES

Instead of place of editing and editor, the full name of faculty/university is given, where the thesis was conducted.

within main text: (Ilić, 2005)

in bibliography:

Ilić, O. 2005

Ranohrišćanski pokretni nalazi na području dijeceze Dakije od IV do početka VII veka, Magistarska teza, Filozofski fakultet, Univerzitet u Beogradu.

within main text: (Patch, 1991)

in bibliography:

Patch, D. C. 1991

The Origin and Early Development of Ur-

banism in Ancient Egypt: A regional Study,
Ph.D Thesis, University of Pennsylvania.

VI ARTICLES FROM NEWSPAPERS

within main text: (Кашанин, 1929)

in bibliography:

Кашанин, М. 1929, Музеј савремене
уметности, *Политика*, 23. јул, 7-8.

13. All of the quoted references are listed after alphabetic order, initial's order within author's surname or the initial letter within the quoted title (if the author or editor are not stated).

SUBMITTING MANUSCRIPTS

14. While submitting, the author should write his/her full contact address in a separate file: address of the institution and e-mail address. If there are several authors, only the contact address of the corresponding author should be written. Author is also obligated to name title and code of the project, i.e. name of the programme under which the article came to being, as well as the name of the institution which financed the project.
15. Each of the submitted manuscripts will be forwarded to anonymous reviewers by the Editorial Board. For further information concerning the peer review process and the Editorial Board's, reviewer's and author's obligations and duties, authors can refer to the EDITORIAL POLICY of the *Arheologija i prirodne nauke (Archaeology and Science)* journal.
16. Manuscripts accepted for printing should be submitted to the editorial secretary via email (archaeo.sci@viminacium.org.rs), and should be divided into several files: 1. .doc (.docx) file with the first six parts of manuscript (1. title; 2. author's name (middle initial) and surname; 3. author's affiliation; 4. abstract; 5. key words; 6. text body); 2. .doc (.docx) file with resume; 3. .doc

(.docx) file with quoted bibliography; 4. Folder with figures and tables; 5. .doc (.docx) file with captions; 6. .doc (.docx) file with author's address.

17. Manuscripts shall be accepted only if they are written and submitted according to the rules stated above. Should author not agree to the requests of the Editorial Board, does not accept remarks of the reviewers (according to the EDITORIAL POLICY) or the proof-reader, manuscript shall not be printed.
18. It is not allowed to change manuscripts after reviews have been submitted, unless they are in accordance with these remarks or according to the proofreading request. Editorial Board holds the right to demand Figures of lesser quality to be replaced with Figures of better quality if necessary.

* * *

For additional explanations, please contact the secretary Emilija Nikolić, PhD (address: Arheološki institut, Knez Mihailova 35/IV 11000 Beograd; phone: 381 (0)11 2637 191 or send an e-mail to: archaeo.sci@viminacium.org.rs.

* * *

These Submission Instructions apply from the next issue of the journal *Arheologija i prirodne nauke (Archaeology and Science)*.

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(*ARCHAEOLOGY AND SCIENCE*)

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