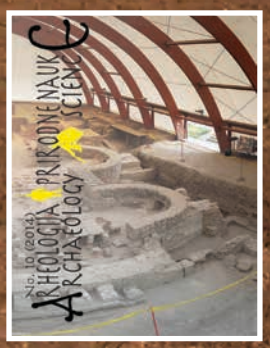

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BEYOND THE EXCAVATION: TOWARDS A CONTEXT-PRESERVING ARCHAEOLOGY THROUGH THE CASE STUDIES OF KOSA AND GRIVAC (ŠUMADIJA) IN SERBIA

ABSTRACT

Although archaeological excavation remains the main method for studying the material record, its destructive nature inevitably devastates archaeological context. This issue was also recognised by Hodder's reflexive archaeology, which did not offer a methodological solution but underscored the ethical responsibility of the researcher. Building on these theoretical foundations, this paper develops a context-preserving archaeological strategy. Its encompassing procedures are aimed at maintaining the original context and enabling data revision without compromising the site's physical integrity. This concept represents a methodological innovation grounded in local experience, given that Serbia's legal framework does not provide a research protocol.

The prehistoric sites Kosa and Grivac were used as case studies to compare the results of mid-20th-century excavations with data obtained through modern non-destructive methods, such as LiDAR, and magnetometry, along with systematic survey. These non-destructive methods enabled the revision of earlier interpretations without further devastation to the archaeological record, which constitutes the fundamental premise of the strategy.

The concept of context-preserving archaeology promotes a proactive ethical approach in which excavation is regarded as a last-resort method, to be applied only in predefined cases outlined in the paper. Such an approach fosters the creation of sustainable and verifiable knowledge while simultaneously contributing to the protection of cultural heritage.

KEYWORDS: CONTEXT-PRESERVING ARCHAEOLOGY, DESTRUCTIVENESS OF EXCAVATION, NON-DESTRUCTIVE METHODS, ARCHAEOLOGICAL RECORDING, DATA VERIFICATION.

INTRODUCTION

Since the very beginnings of archaeology as a scientific discipline, the principal method of archaeological research has been excavation — the physical removal of the archaeological record contained within the stratigraphic units of the soil. This process involves the precise documentation of all changes in the soil, including its morphology, structure, and colour, as well as the exact position of archaeological finds. The collected data is preserved through documentation produced during all stages of the research, which, once excavation is complete, often constitutes the only

source of information[1] on the excavated area and the context of the finds, which no longer exists (Barker 1986: 108; 1993: 13; Olsen 2002: 264–265; Lucas 2001; Грин 2003: 104–105; Faniel *et al.* 2013: 296). Since archaeologists often rely on destructive methods of data collection, which destroy the sites they seek to understand, the issue of preserving and reusing archaeological data is of crucial importance (Faniel *et al.* 2013: 296-297). The destructive nature of excavation entails that the excavated soil layers and the finds within them are permanently displaced from their original context, making it impossible to verify the available data through subsequent excavations. All further scholarly work relies exclusively on the information recorded at the time of the investigation and on archaeological material stripped of its taphonomic context, without the possibility of additional *in situ* verification (Pollard 2015: 392; Tasić 2015: 10–11).

Starting from the premise that archaeological excavation is inherently destructive, this paper aims to critically reassess the limits of traditional methodology and to explore the potential of contemporary, primarily non-invasive or minimally invasive research techniques as part of a broader strategy for preserving archaeological context. Through case studies of the prehistoric sites of Kosa and Grivac in the Šumadija region, the paper analyses the possibilities of combining limited excavation and non-invasive methods to obtain reliable data with minimal intervention into the archaeological layer. The paper aims to illustrate the strengths and weaknesses of both traditional excavations and non-destructive methods in interpreting archaeological sites by analysing the range and character of data produced through the different research approaches. Based on these insights, clear criteria are proposed to justify the application of invasive techniques, while in all other cases, a context-preserving strategy is recommended.

Although the term context-preserving has already been used several times in this paper, it has not yet been employed in this specific sense within academic discourse. It is, therefore, defined here with precision. In its broadest sense, the context-preserving paradigm includes all procedures and methods intended to safeguard the original context. It also seeks to ensure that data can be re-examined without causing permanent harm to the physical integrity of an archaeological site or the broader cultural landscape. This concept is based on a methodological framework in which non-invasive techniques serve as the main data source. In doing so, it reduces destructive interventions and helps to preserve the archaeological context. This approach is in accordance with Article 3 of the *European Convention on the Protection of the Archaeological Heritage (Revised)* (La Valletta, 1992), which explicitly recommends the use of non-destructive methods of investigation whenever possible. Within this framework, excavation is strictly limited and undertaken only when necessary to obtain information that cannot be accessed in any other way.

Although the principle of precise and capacity-based excavation has long been recognised in international archaeological discourse, its consistent implementation remains uneven across different countries. In Serbia, archaeological practice continues to be largely excavation-oriented, with limited application of non-destructive and analytical methods as an obligatory component of research. The concept of context-preserving archaeology proposed in this paper represents a methodological innovation grounded in local experience, given that no national legal framework currently mandates the use of non-destructive methods as an integral part of research protocols. Their application, therefore, largely depends on individual researchers' decisions, whose theoretical and methodological standpoints often differ.

While such regulations are still lacking in Serbia, several counties have established legislative and methodological frameworks that directly address the destructive nature of excavations. In developing this concept, particular attention must be given to the principles of minimally invasive archaeology (e.g., Hanks and Doonan 2012), which gained significant momentum within North American

[1] On the nature of archaeological data, its recording (documentation), and interpretative value, see Палавестра 2020: 29–32 with references.

archaeology following the adoption of the Native American Graves Protection and Repatriation Act (NAGPRA) in 1990 (National Park Service 2023). This legislation strictly limited excavation to cases that met specific criteria, which, in turn, encouraged the development and broader use of non-invasive research methods. Similarly, since the 1980s, cultural heritage policies in China have emphasised the preservation of archaeological sites for future generations, permitting excavation only at selected sites, given its inherently destructive nature (郑滨 2021).

Although awareness of the destructive nature of excavation has existed since the early development of the discipline, Ian Hodder was the one who problematised this aspect and formulated it into a theoretical form through the concept of reflexivity (Hodder 1999: 26). By introducing the notion of reflexivity into discussions about the scope and limits of archaeological interpretation, Hodder argued that interpretations are always influenced by the context of the research and by the researcher's own perspective and experience. He insisted that the researcher must maintain an awareness of the positionality from which interpretation is undertaken (Hodder 1999: 66–79). In doing so, Hodder highlighted the paradox whereby archaeological knowledge is produced through the destruction of primary evidence. Even when the interpretation arises directly from the researcher's engagement with material remains rather than from a predefined theoretical framework, this relationship remains inherently subjective, shaped by the sensory and experimental aspects of the encounter itself (Edgeworth 2016: 91). Such interpretation can never be epistemically value-neutral, and it requires continual self-reflection on the conditions of its production. Therefore, although it did not provide a concrete methodological solution, the concept of reflexivity stressed that all interpretation should be seen as temporary and dependent on the researcher's standpoint and the historical moment in which it was produced, and is, therefore, always open to critical review and reinterpretation.

In this light, the development of context-preserving practices can be seen as a natural extension of Hodder's concept of reflexivity, as an attempt to address its limitations through the integration of modern, non-invasive methods that enable an extended analytical life of the dataset and documentation, as well as their continual critical re-examination. Recent research on data reuse (see Ward 2024: 219-221 with older references) indicates that the long-term usability of archaeological data largely depends on understanding the primary context in which the data was produced. This enables research to adequately assess legacy data, ultimately determining the level of trust in the results of previous investigations. Therefore, the long-term usability of archaeological data relies on the quality of contextual documentation and the standardisation of procedures of its recording, preservation, and sharing (Faniel *et al.* 2013: 297-299). As a consequence, the context-preserving approach addresses the key challenges of contemporary archaeological practice. On the one hand, it entails responsible management of sites for the benefit of future generations, while on the other, it is directed towards ensuring the long-term verifiability of data. Although the concept of data reuse naturally aligns with these objectives, its detailed analysis would require separate consideration that goes beyond the scope of this paper.

RESEARCH QUESTIONS AND METHODOLOGY: ARCHAEOLOGICAL EXCAVATION AND THE CHALLENGE OF ENSURING DATA VERIFIABILITY

The fact that archaeology is wholly dependent on the quality of primary field data has been a central tenet of archaeological methodology since the discipline was first established (Wheeler 1954: 1–6; Barker 1993: 150–153). This principle was recently reiterated by Pat Tanner (Tanner 2024: 5), who emphasised that: "all archaeology is contingent on the source data, and everything stems from that. Achieving a detailed understanding of both the object and the processes is predicated on the quality of the underlying source data." This observation remains as pertinent today as it has ever been, since every analysis, interpretation, or reconstruction in archaeology inevitably relies on the quality of the primary field documentation produced during excavation.

However, attention should also be paid to archival archaeology, which has been a significant development over the past decade. In the works of Baird and McFadyen (2014) and Faniel *et al.* (2013), it has been demonstrated that legacy datasets, although incomplete or fragmentary, can yield valuable insights when their contextual framework is critically examined and compared with contemporary analytical methods. In this sense, the value of archaeological archives does not lie in replacing primary data but in extending its analytical usability through reinterpretation and reuse. Moreover, it is of particular importance for future research, as it preserves information that may be reinterpreted through new analytical techniques and technologies that will be developed in the future.

Thus, unlike other disciplines, archaeology faces a unique epistemological challenge: the irreproducible and destructive nature of excavation inherently limits the possibility of subsequent *in situ* verification of data. According to modernist philosophical considerations concerning the nature of scientific knowledge, "every empirical claim must be subject to verification in order to determine its truth or falsityt (Berberević 1990: 141), and verifiability is generally regarded as a foundational principle of scientific methodology. From the standpoint of reflexive archaeology, however, there is no basis for speaking of absolute truths about the past, nor for a value-neutral position of the researcher. On the other hand, if a scientific claim cannot be verified, its epistemological value remains limited, as it is impossible to demonstrate its validity beyond doubt (Bešić 2019: 22–23). Archaeology, therefore, occupies a paradoxical position — striving for objectivity and verifiability while fundamentally being constrained by the irreversible loss of the primary context through excavation. This epistemological anxiety is further amplified by the selective and destructive nature of excavation, as what was not recovered is lost forever, while what was recorded is inevitably shaped by the preconceptions and understanding of its time (Wylie 2017: 1). Post-processual critiques responded to this paradox through the concept of reflexivity, framing it as a theoretical answer to the impossibility of complete objectivity and as a call for the constant re-evaluation of the processes by which archaeological knowledge is formed.

The destructive nature of archaeological research presents a significant challenge to assessing the validity of archaeological interpretations. When using data derived from excavation, we must confront the reality that: "The quality and detail of the source data are directly proportional to the accuracy of the measurements recorded" (Tanner 2024: 7) and that the meticulous documentation of all processes and finds is essential to subsequent interpretations and conclusions (Goldberg *et al.* 2006: 380). This fact is closely related to the inherently subjective perspective of the researcher who, while observing and documenting all available information, often unconsciously selects aspects of the data that will later form the basis of contextual interpretation.

An additional problem lies in the lack of standardisation of quantitative data in the recording, collecting, and long-term preservation of data (Drennan 2009, Esteva *et al.* 2010), which can sometimes exert a greater influence on interpretation than the researcher's own subjectivity. STEM disciplines established and standardised their professional language, terminology, and protocols early in their development. This arose from the evident need for precision in fields such as mathematics or genetics. By contrast, in archaeology, there is a tendency to conflate professional, vernacular, and even ideological registers, often producing excavation records of quantitative data in formats that reflect the localised decisions of a single individual or team. Such legacy datasets frequently lack georeferencing, consistent terminology, or adequate metadata, which severely limits their interoperability and the potential for quantitative or comparative analysis (Faniel *et al.* 2013: 295-297; Huggett 2018: 8-9). In many cases across the region, it is common to encounter situations where museums preserve archaeological material from older excavations, while the accompanying documentation has been permanently lost, either partly or entirely, due to the flexible state regulations in the past regarding the long-term archival preservation of excavation record. These deficiencies and limitations in the archaeological record significantly affect its usability in spatial modelling, quantitative comparisons, or reanalyses employing contemporary methods, unless a thorough reinterpretation and reconstruction

of context and metadata is undertaken. This is particularly evident in the transition from analogue to digital recordkeeping, which involves CAD and GIS models and requires a precise contextual framework for the meaningful interpretation of data (Faniel *et al.* 2013: 296).

The problem of subjectivity becomes even more pronounced in the interpretive phase, as archaeologists seek to relate limited data to the complex aspects of past communities. This task inevitably involves interpretations grounded in assumptions, analogies, and the individual theoretical commitments of the researcher. This process often yields conclusions that are based more on the interpretations of other scholars than on definitive evidence (Anichini 2012: 101). This reflects the fact that, in practice, there is no purely objective apprehension of reality, but only a subjective one, shaped by the interaction between the senses and the external world, thereby inevitably compromising objectivity (Bešić 2019: 21).

This process is further complicated by the temporal distance between the act of interpretation and the time at which the material remains were created (Pollard and Bray 2007: 246; Каличанин-Крстић 2024: 176) — a separation which, as Hodder emphasises, necessitates a reflexive stance on the part of the researcher regarding their own role; that is, an awareness of the ways in which personal experiences, beliefs, and attitudes shape the construction of archaeological knowledge (Hodder 1999: 102–103).

Despite sustained efforts toward objectivity and value-neutrality, the complex relationship between material remains uncovered in the present and the social systems of the past demands interpretations grounded in the researcher's understanding, analogical reasoning, and ability to reassess their own biases critically — all of which can influence both the selection of data and the conclusions drawn (Pollard 2004: 393; Greene 2004, 2006: 159; Anichini 2012: 101; Chapman and Wylie 2016: 61, 68). This reliance on interpretive approaches has led to a widely accepted view within certain academic circles that archaeology: "re-creates the past on the basis of indirect or proxy evidence" (Ch'ng *et al.* 2011: 48) and constitutes an interpretive construct reliant on provisional and always conditional conclusions of the researcher (Chapman and Wylie 2016: 6).

Given the particular nature of archaeological knowledge, an epistemological question arises: how can we verify the accuracy of the available data and prevailing interpretations if the archaeological context has been destroyed?

In confronting these challenges, numerous debates have emerged about the status of archaeology as a scientific discipline, ranging from its denial to the affirmation of its scientific principles (Pollard and Bray 2007: 247; Chapman and Wylie 2016: 2-4). Among other things, these discussions inspired Pollard's pointed remark: "Which other discipline spends so much time on internecine warfare about the very nature of itself?" (Pollard 2004: 382), which aptly illustrates the complexity of archaeology and the methodological dilemmas it faces.

Data obtained through excavation largely constitutes the primary empirical framework for interpreting material remains, particularly for periods without written sources. However, in periods with written sources and preserved above-ground architectural remains, it is possible to develop a sound interpretation even in the absence of excavation results. It can be achieved through the critical reading of written sources in combination with spatial analyses and an assessment of the topographical context.

Given that excavation irreversibly destroys archaeological context, modern interpretations increasingly rely on documentation and methods derived from the natural and technical sciences. Although technologies and analytical techniques such as LiDAR, magnetometry, and geochemical analysis are currently widely applied, they cannot replace excavation in collecting stratigraphic, chronological, or material data. Their primary purpose is to complement excavation with spatial and contextual information, thereby enabling the revision and expansion of existing interpretations. The conclusions reached must be critically reassessed through cross-analysis of independent sources. In domestic practice, there are already numerous examples of archaeological interpretations that have been revised as a result of integrating modern technologies into archaeological research.

In the following section, we will present two case studies that demonstrate the potential for verifying, revising, and expanding existing

archaeological knowledge without the need for renewed excavation. Such re-evaluations are often prompted by new insights obtained from other sites of the same type and chronological framework. In this way, a broader interpretative context is established, encouraging the re-examination of previously drawn conclusions.

RESULTS

The archaeological sites of Kosa and Grivac in the Šumadija region (**Figure 1**) have been selected as case studies to illustrate the theoretical discussion outlined above. Both were investigated during the second half of the 20th century, when initial archaeological conclusions regarding their character and role in the landscape were formulated. The examples provide a basis for demonstrating how contemporary methods enable the critical reassessment and revision of existing interpretations.

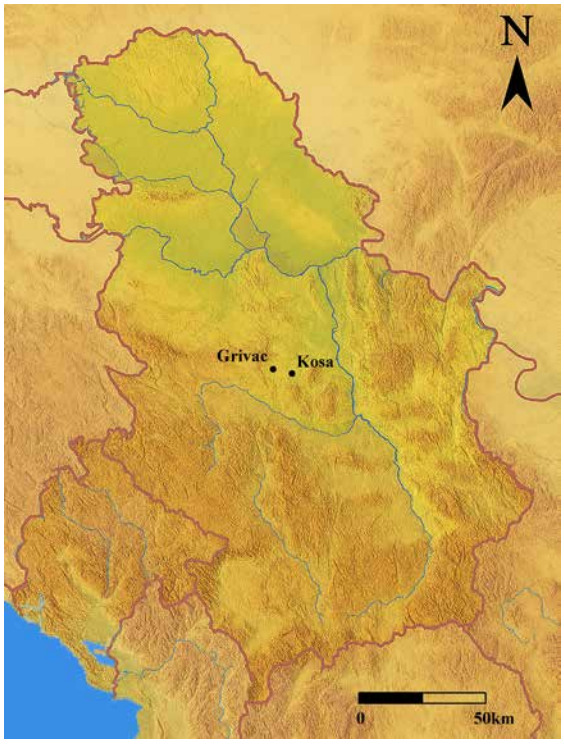

Figure 1. Location of the sites of Kosa and Grivac within the territory of Serbia (base layer: Copernicus DEM GLO-30; mapping and cartographic elements done by the authors).

Kosa

The site of Kosa is located in the village of Korićani (City of Kragujevac) and occupies a prominent elevation above the Lepenica river, at approximately 300 metres above sea level (**Figure 2**). It constitutes an important source for the study of prehistory, particularly concerning settlement patterns and spatial organization during the Eneolithic period in this area. Small-scale excavations, covering an area of just 11 m², were conducted in 1958 by a team from the National Museum in Kragujevac (Петровић и Минић 1958;[2] Богдановић 1983: 9–26). Within a cultural layer measuring 0.80 metres in thickness, the remains of a semi-subterranean dwelling and two habitation horizons were uncovered: one attributed to the Baden culture and the other to the Kostolac cultural group[3] (Јовановић и Јончић 2025). Based on the artefacts, the site was dated to the Eneolithic (ca. 3700 – 2800. BC).[4] Later publications interpreted the remains and the topographical position of the site as indicative of a fortified hilltop settlement (Богдановић 1981: 41; Мадас 1998: 123), an interpretation based primarily on the topographical features of the site and on the limited data from the interior of the settlement.

Nearly six decades later, in 2025, new investigations were carried out that did not involve traditional archaeological excavation but were, instead, based on field reconnaissance and LiDAR terrain scanning (Јовановић и Јончић 2025). It aimed to verify and, where necessary, revise the earlier interpretation of the site's characteristics and

[2] We are grateful to our colleague Igor Đurović of the National Museum of Šumadija for providing the documentation.

[3] The problem of defining archaeological cultures and cultural groups, as one of the most deeply rooted products of culture-historical archaeology, represents a critical yet sensitive issue in contemporary archaeology. Over the past decade, a growing number of studies in domestic scholarship have critically examined this problem, highlighting the need to revise the concept (see Kuzmanović 2012; Bandović 2012; Porčić 2013; *et al.*). In this paper, we apply an interpretation of cultural groups in line with the theoretical paradigm dominant at the time. At the same time, a detailed discussion of this complex issue lies beyond the scope of the present study.

[4] The site belongs to the Baden-Kostolac cultural group, dated between ca. 3700 and 2800 BC according to radiocarbon data (Wild *et al.* 2001).

spatial boundaries. The surface survey recovered ceramic material consistent with that documented in the 1958 excavations, confirming the site's Eneolithic date. However, dense vegetation in the outer boundary areas prevented a complete survey and limited the scope of a detailed field analysis.

LiDAR scanning (**Figure 3**) provided new insights into the spatial organisation of the site. Previous excavation data was limited to a small

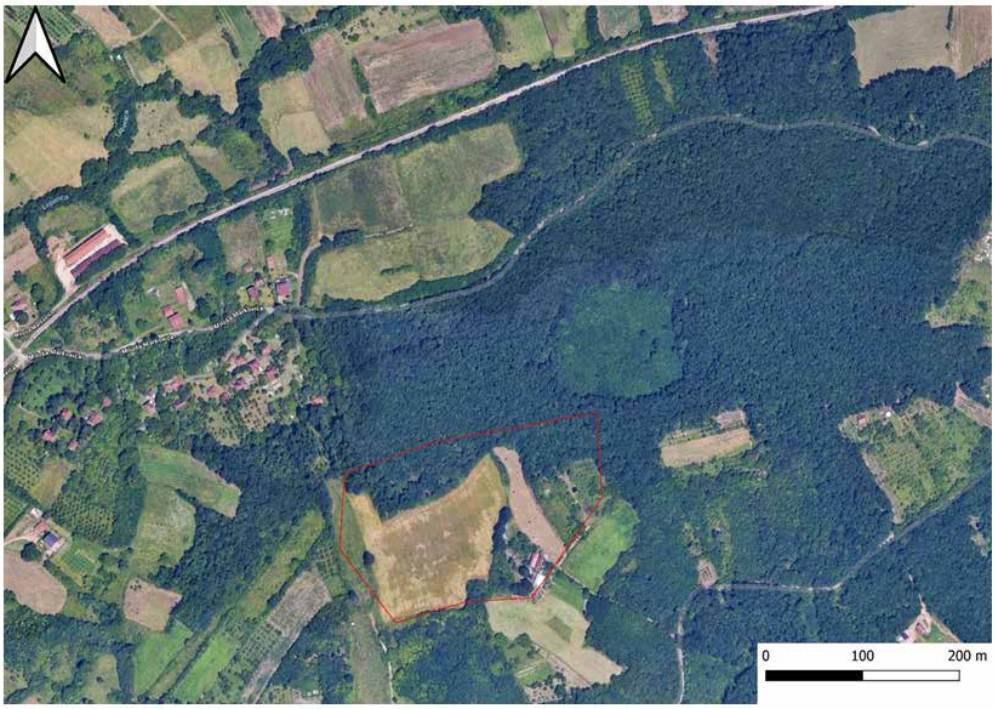

Figure 2. Spatial extent of the Kosa site on a satellite image (outlined). Source: Google Earth, processed by Јовановић и Јончић (2025: 4, сл. 1).

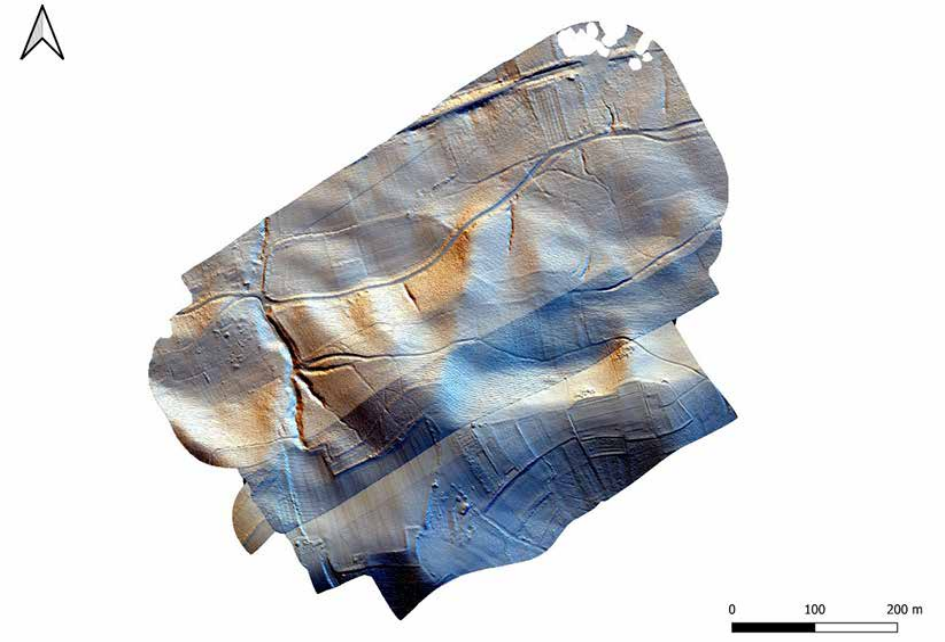

Figure 3. LiDAR imagery of the Kosa site showing terrain morphology and the absence of visible fortification features (Јовановић и Јончић 2025: 9, сл. 7).

Site	Traditional methodology	Results	Multidisciplinary methodology	Results	Necessary minimal intervention
Kosa	1958. Excavated 11 m^2	**Chronology:** Eneolithic (Baden/ Kostolac) **Features**: one pit-house; two occupation layers attested **Interpretation:** fortification	2025. LiDAR Surveyed area 31.3 ha	Confirmed chronology Distribution area of findings No evidence of hillfort **Correction:** Open settlement	Small scale excavations for verification of boundary zones and precise stratigraphy (e.g., check fortifications/ fence, dating)
Grivac	1952-1994. Excavated 576 m^2	**Sites Defined:** Barice I, Barice II, Gruža I, Gruža II **Chronology:** Neolithic (Starčevo, Vinča) **Features:** 8 pit-houses, 26 above-ground houses (Partially excavated) **Interpretation:** Open settlement	1969. 2016–2021. Magnetometry Surveyed area 50 ha	One settlement Confirmed chronology Over 120 houses in units Organized urban plan Discovery of moat system **Correction:** Fortified settlement New hypothesis on defence	Targeted excavation to determine the chronology of ditches (whether simultaneous, when used) and their relation to Starčevo–Vinča phases.

Table 1. Comparative overview of results obtained through traditional and multidisciplinary methodologies at the sites of Kosa and Grivac, with corresponding interpretative revisions and recommendations for minimal necessary interventions.

area within the interior of the site, offering no information on possible boundary zones or the presence of defensive structures. The initial interpretation of the site as a fortified hilltop settlement was derived from the presence of semi-subterranean dwellings in combination with its topographical features. Although formulated in an early phase of research, this interpretation was contextually motivated, a common feature of initial interpretative models in archaeological practice. However, the LiDAR scan revealed no traces of ramparts or other fortification elements. This finding prompted a revision of earlier conclusions and led to the reinterpretation of Kosa as an open-type settlement lacking fortification architecture (Јовановић и Јончић 2025). In other words, the new data indicates that the site of Kosa represented an open settlement without fortifications. The key differences in methodology, data, and interpretation are summarised in **Table 1**.

Grivac

The site of Grivac, situated on a geological ridge above the Gruža river in the village of the same name (in the municipality of Knić), is one of the most important Neolithic sites in the Šumadija region. Its significance lies in its complex stratigraphy, large surface area, and the long-term continuity of archaeological research. Systematic excavations, conducted intermittently between 1952 and 1994 (**Figure 4**), were carried out by the Institute of Archaeology in Belgrade, the Faculty of Philosophy at the University of Belgrade, and the National Museum in Kragujevac. Throughout these investigations, a total area of 576 m² was excavated (Bogdanović 2004: 17).

Significant conclusions about the settlement patterns at the site were reached even in the earliest stages of excavation. It was assumed that multiple Neolithic sites existed on the plateau, treated as separate units and designated as Barice I, Barice II, and Gruža (Gruža I and II). These zones formed the basis for all subsequent interpretations. The cultural layer varied in thickness from 1.2 to 3.2 metres and contained numerous pits. Excavations uncovered eight semi-subterranean dwellings and twenty-six above-ground rectangular houses, none of which was fully excavated. In the absence of defensive structures, such as ditches, palisades, or ramparts, it was concluded that Neolithic settlements at Grivac were open and densely clustered. Based on the archaeological finds and by the chronological schema in use at the time, the settlements were dated to the Neolithic (6200-5300 BC)[5] (Гавела 1956–1957: 238; Станковић 1990: 61–63; Srejović 1997: 336; Bogdanović 2004: 10, 21, 494, karta 1.2; Kočić 2019: 120).

Alongside excavations, reconnaissance surveys were also undertaken. In some phases of the research, these included broader fieldwalks, aimed at determining the spatial distribution of archaeological material. Since 2017, this type

[5] Dating according to Stefanovic *et al.* 2020.

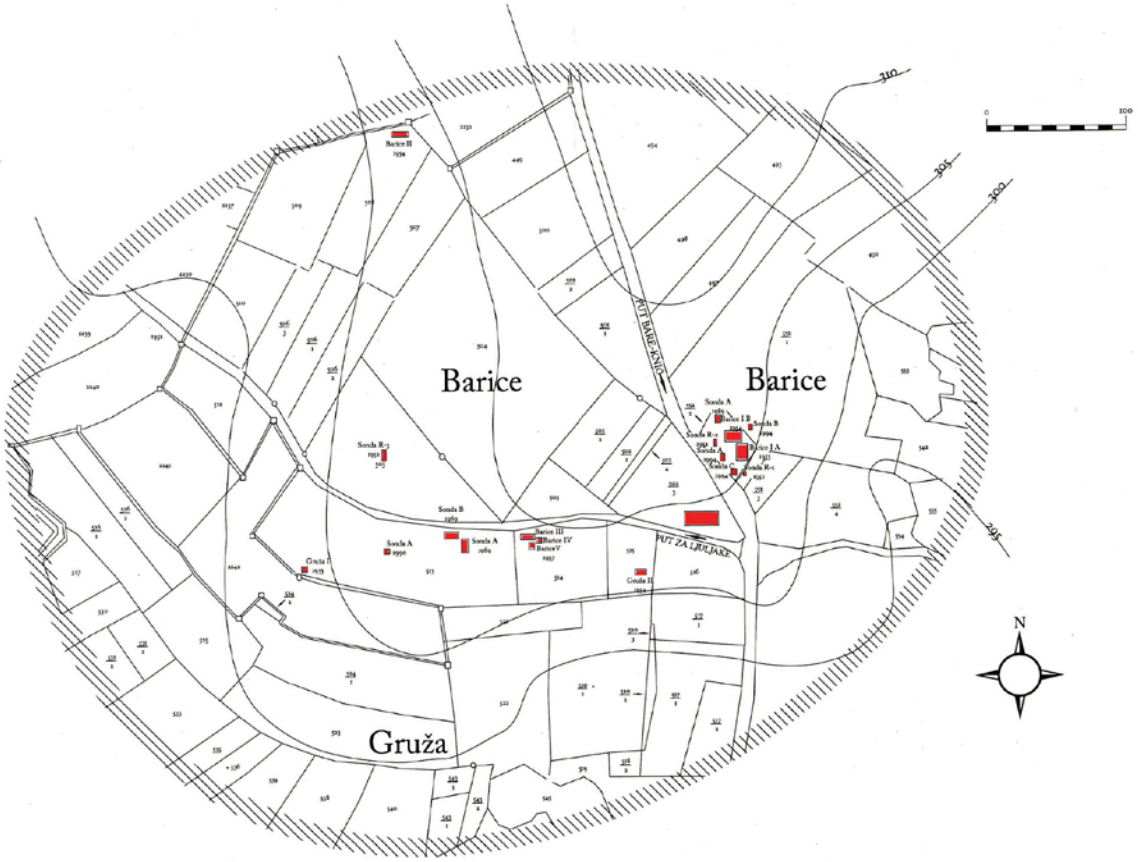

Figure 4. Site grid with earlier excavation trenches (Bogdanović 2004: karta 1.2).

of investigation has become systematic and has been implemented as a separate methodological unit known as surface prospecting. It involves planigraphic analysis of the terrain and the collection of movable archaeological material from precisely defined surface units, suitable for statistical and stratigraphic processing.

Using the results of this method, the distribution of archaeological finds was examined within the framework of horizontal stratigraphy. Starčevo material was identified across an area of more than 50 hectares, while Vinča finds were concentrated within an area of 28 hectares. Taken together, the evidence from surface collection points to a single, unified site — a conclusion that stands in direct contrast to interpretations drawn only from the 1958 excavation.

Although surface prospecting alone cannot definitively confirm or refute the hypothesis regarding whether the settlement was open or enclosed, the spatial distribution of material from the Vinča period, collected during systematic reconnaissance, points to a concentration of finds exclusively within the settlement zone (Kočić 2019: 132–142). This data has enabled the reconstruction of the settlement's internal organisation and the identification of activity zones across the broader community space. The archaeological approach was, thus, oriented toward the analysis of functional relationships between cultural phases and the reconstruction of everyday life and the spatial organisation within the settlement.

Zones of specialized activity were identified: in the north-western part of the site, a concentration of large storage vessels suggested food storage activities; large tools were found mainly along the settlement's periphery; and the widespread presence of pottery led to the assumption that most households were engaged in ceramic production (Гавела 1956–1957: 238; Kočić 2019: 120–142, 180–191, 218–229, fig. 6.3, fig. 6.5; Каличанин-Крстић 2024: 91–101, 126–133).

Unlike the site of Kosa, where modern technologies were applied six decades after the initial excavation, the first geophysical survey at Grivac was conducted as early as 1969. This research forms part of a collaborative project between the University of Pittsburgh and the Faculty of Philosophy in Belgrade, within the framework of the Šumadija Regional Geoarchaeological Project (SRGAP) and the "Early Farming Cultures in Central Serbia" project. Cooperation between Serbian and American institutions was renewed in 2016, through a joint initiative by the University of Pittsburgh and the Institute for the Protection of Cultural Heritage in Kragujevac, this time employing exclusively non-destructive and minimal-invasive research methods (Богдановић 1983: 23, 24; Mužijević and Ralph 1988: 339; Srejović 1997: 336; Bogdanović 2004: 13, 14; Кочић и др. 2023: 124–128; Каличанин-Крстић 2024: 47).

The results of magnetometry surveys (**Figure 5**) indicated the presence of a single, coherent site in this area. Geophysical anomalies, based on their size, shape, and orientation, were interpreted as the remains of floors of above-ground residential structures, the number of which exceeded 120 in the obtained imagery. The structures were arranged in rows and grouped into smaller clusters of several houses, with distances between them in some cases being less than two metres. The main thoroughfare running through the settlement was oriented in a northwest–southeast direction (Mužijević and Ralph 1988: table 15.2; Bogdanović 2004: 159; Kočić 2019: 120, 129, 131, 157, 159, 183, 197, fig. 5.3, fig. 5.55; Каличанин-Крстић 2024: 134–137).

A key difference from previous investigations was the identification of a system of ditches along the perimeter of the site, recorded during magnetometry surveys conducted between 2016 and 2021. The discovery of these features challenged earlier interpretations of the appearance and organisation of the settlement at Grivac and prompted a reassessment of previous conclusions (Гавела 1956–1957: 238). The imagery revealed five major ditches, along with numerous minor anomalies occurring between them in some sectors. Although the current state of research does not allow for definitive confirmation as to whether all the ditches were contemporaneous, their presence indicates a phase in which the settlement was physically enclosed from the surrounding landscape. It likely corresponds to the transitional period between the Starčevo and Vinča cultures (Kočić 2019: 142).

Possible reasons for building such complex systems range from protection against

Figure 5. Geophysical survey results up to 2018 at the site of Grivac (Каличанин-Крстић 2024: 112, слика 5).

environmental threats (e.g., wild animals and floods) to defence from other communities. The scale and number of ditches suggest a high level of social organisation and collective effort, prompting important questions about the community's internal structure and its interactions with neighbouring groups in the region. In this context, the possibility of increased conflict cannot be ruled out, which may have been a motivating factor for the construction of such monumental defensive structures (Kočić 2019: 34, 48, 181 fig. 5.4; Каличанин-Крстић 2024: 112, 135, 150).

* * *

In light of the new insights gained through the application of non-destructive methods, it is important to emphasise that these techniques enabled the rapid and systematic collection of spatial data, thereby significantly expanding or, in some cases, revising earlier interpretations based solely on traditional archaeological excavations. The results, presented in this paper as a synthesis of data from diverse sources, have allowed for a far more comprehensive reconstruction of the spatial organisation and developmental phases of the settlement (**Table 1**).

DISCUSSION

Methodological reflections on the Kosa and Grivac case studies

The previous section presented the essential data from the archaeological sites of Kosa and Grivac, with the key findings summarised in **Table 1**. These two examples provide a clear framework for understanding both the scope and the limitations of traditional archaeological research, as well as the potential offered by contemporary multidisciplinary approaches.[6] In

[6] Comparable methodological considerations have also been particularly developed within forensic archaeology, where the special attention devoted to procedural efficiency and ethical responsibility, and minimal disturbance of the authentic context (see Dirkmaat *et al.* 2016) directly parallels the aims of the context-preserving practice proposed in this paper. Although forensic archaeology has already taken steps towards a methodology of context preservation within the framework of procedural efficiency, its ethics are directed towards responsibility to the victim and the court. In this paper, the principle of context preservation is applied within the framework of epistemological responsibility, and its ethics are directed toward responsibility to scientific knowledge and the preservation of cultural heritage. In this way, the concept of context preservation is elevated from a technical to a theoretical level.

both cases, traditional excavations constituted the initial step in documenting the stratigraphy and the fundamental spatial characteristics of the sites.

At the Kosa site, trial excavations established the site's chronology and proposed an interpretation of the settlement as a hillfort. Systematic excavations at Grivac initially suggested the existence of multiple settlements and various building types, without identifying any fortification elements.

However, modern methods (in these cases, LiDAR and magnetometry) have shown that earlier assumptions can be revised when a site is examined within a broader context and through the application of multiple different techniques. At the site of Kosa, the absence of ramparts demonstrated that the settlement was not fortified in the hillfort form. At the same time, at Grivac, the discovery of a ditch system disproved the notion of an exclusively open settlement.

The chronological development of the quantity and quality of data obtained from the total body of research at both sites is presented in a diagram (**Figure 6**), with particular emphasis on the impact of various methodological approaches from the mid-20th century to the present. Therefore, non-destructive methods such as LiDAR and magnetometry provide key datasets for the spatial analyses of archaeological sites. However, reinterpretation ultimately depends on their integration with existing evidence and the critical reassessment of previous conclusions in accordance with contemporary theoretical and empirical knowledge.

In the case of Kosa, the stepwise curve shows a minimal initial increase in data during the 1950s, when only 11 m² were excavated. This phase produced the first interpretation of the site as an Eneolithic hillfort. After a long period without new data, the curve rises sharply in 2025, when LiDAR scanning and reconnaissance are carried out. This methodological leap brought an exponential increase in the amount of information, enabling the expansion of the surveyed area and the revision of previous interpretations, ultimately concluding that the site was not a fortified settlement. This result becomes a new reference point, contributing to the broader interpretation of settlement dynamics in the Šumadija region and, indirectly, in the wider Central Balkan area. These methodological advances have fundamentally reshaped our understanding of the past.

For the site of Grivac, the stepwise curve reflects a continuous increase in data in the first

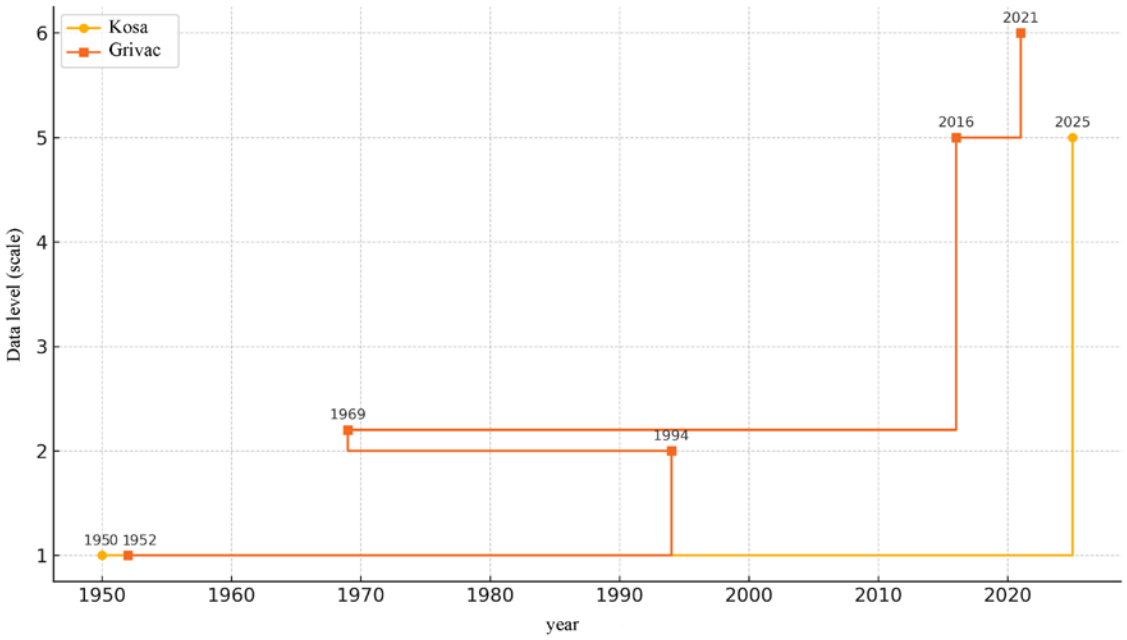

Figure 6. Stepwise diagram of data accumulation in relation to the research methodology over time at the sites of Kosa and Grivac.

phase (1952–1994), during which more than 576 m² were excavated. These excavations identified numerous structures, but the settlement was interpreted as a system of multiple distinct units, with no indications of defensive features. In parallel, the first methodological leap occurred in 1969 with the introduction of geophysical surveys. However, the most significant expansion of data took place after 2016, with the application of advanced magnetometry techniques. These revealed more than 120 houses, spatial organisation patterns, and defensive ditches, all of which transformed the prevailing understanding of the site's character (Benac, Garašanin i Srejović 1979: 662).

This sudden increase in data quantity and the shift in interpretative perspective prompted new questions regarding security, organisation, and inter-community relations during the Neolithic. The Grivac example illustrates the importance of reinterpreting a site, as such changes have the potential to reshape knowledge of the broader chronological framework. For instance, the long-standing narrative of the Neolithic as the most peaceful period in the history of civilisation has been increasingly called into question over the past decade. The notion, widespread in regional archaeology, of the Neolithic as a peaceful era has been undermined by evidence from sites of that period which, once surveyed using geophysical methods, have consistently revealed the presence of fortifications (Crnobrnja, Simić and Janković 2010; Балабан 2013; Borić *et al.* 2018; Perić and Korać 2019; Hoffman *et al.* 2019; Kočić 2019; Кочић и др. 2023; Milanović, Živanović i Antonijević 2024).

To summarise, the key message of the stepwise diagram is that the increase in archaeological data in these cases does not follow a linear trajectory but occurs in distinct leaps, closely linked to the introduction of new methods into archaeological practice. The transition from traditional excavations to a combined multidisciplinary approach results in exponential growth in the number of identified structures, critical reexamination of existing hypotheses and interpretations, and the formulation of new research questions It directly supports the concept of context-preserving archaeology, which relies on minimal intervention. Excavation is carried out only when needed to confirm key stratigraphic and chronological data. To reconstruct the past reliably, all available non-destructive methods must be used alongside contemporary theoretical frameworks. This approach seeks the highest possible accuracy and credibility.

The case studies of Kosa and Grivac demonstrate that responsible archaeological practice requires a precise balance between excavation and non-destructive methods, which brings us to the following question: When and why should we dig? In a broader sense, this approach also opens up space for future research focused on the reuse of both old and new data, representing a logical extension of the methodological and ethical principles on which context-preserving archaeology is founded.

Strategy and balance: when and why to excavate?

Establishing clear criteria for justified excavation is one of the fundamental ethical questions in contemporary archaeology. Such decisions must always be based on the assessment of multiple interdependent factors. In the modern world, characterised by accelerated development and large-scale infrastructure projects, such assessments are primarily based on the extent to which human or natural agents threaten a site. The permanent destruction of archaeological layers due to construction, infrastructure, or other land-use interventions is one of the principal reasons for conducting excavations, as this allows for the maximum preservation of data for future scientific interpretation (Pollard 2004: 393). At the same time, excavations at endangered sites allow the documentation of context and the planning of protection, conservation, or presentation. In such cases, removing archaeological layers is justified when their preservation is no longer possible.

An equally significant reason for excavation is the acquisition of data essential for advancing archaeological knowledge. However, the extent of such excavations must be carefully weighed against the possibility of obtaining equivalent or similar information through non-destructive methods. Data generated by contemporary technologies is not, in itself, sufficient for archaeological interpretation unless integrated

into a broader context. Despite its limitations, only excavation provides "contextual evidence crucial to interpretation" (Pollard and Bray 2007: 257) and, thus, remains an irreplaceable element of archaeological research (Kočić 2020: 100).

In the context of archaeological excavation, it is important to emphasise that the quantity and quality of results depend on factors such as funding, the size of the area investigated, and the site's natural conditions and preservation state. In some cases, limited excavations may yield only minimal data, while in others, a similar scale may reveal complex archaeological features. This variability underscores the ethical dilemma: when are destructive interventions essential, and to what extent?

For this reason, contemporary archaeology increasingly recognises the context-preserving paradigm. This framework combines non-destructive methods with interdisciplinary interpretations of the archaeological record. It also emphasises the need to conserve material resources for future research.

Depending on the circumstances, scientific and educational needs, and the degree of site endangerment, the following criteria can be identified as justifying archaeological excavation:

1. A scientific hypothesis that cannot be resolved through non-destructive methods.
   Example: At the site of Kosa, small-scale trial excavations would be justified to verify the boundary zones of the site and to establish precise stratigraphy.

2. The absence of viable alternative non-destructive methods.
   Example: At the site of Grivac, targeted probing would be warranted in order to verify anomalies recorded through magnetometry.

3. Imminent threats that pose a risk of destruction of archaeological layers.
   Example: Although the case studies presented here are not currently endangered by natural or human activity, should such threats emerge, it would be necessary to undertake preventive rescue excavations. In this way, the data would be permanently preserved through archaeological documentation.

4. The need for precise chronological determination.
   Example: For both sites, targeted small-scale excavations of selected archaeological features would be justified to collect organic samples for radiocarbon dating.

5. Verification or revision of the results of previous excavations.
   Example: At Grivac, targeted excavations would be warranted to determine the chronology of the ditches and the relationship between the Starčevo and Vinča phases.

6. Educational purposes.
   Example: At both sites, excavations could be undertaken for student training, but only in areas that have already been investigated and documented.

In this way, combining all available non-destructive methods with clear criteria for excavation helps create a strategy that balances the search for new knowledge with the responsible preservation of archaeological heritage. All justifications for excavation should be critically assessed, considering the scope and intensity of intervention, and ensuring that the aims are fully warranted. Such assessment should be grounded in the fullest possible utilisation of data derived from non-destructive methods, which constitute the primary line of research and analysis, as already emphasised by K. Green (Грин 2003: 140–141).

In the previous sections, the results of magnetometry and LiDAR scanning were presented as examples of non-destructive remote sensing methods. However, the spectrum of such techniques is considerably broader. **Table 2** provides an overview of the non-destructive methods currently available, together with their principal advantages and limitations.[7] It should be noted that this list reflects the range of methods accessible at present; it is possible that new techniques have already been developed in specific research contexts but are not yet widely known or applied. Moreover, further development

[7] For a comprehensive view of the range and application of non-destructive methods in archaeology, see Siart, Forbriger and Bubenzer 2018; Leucci 2019.

Method	Brief Description	Advantages	Limitations
LiDAR (Light Detection and Ranging)	Airborne laser scanning that generates a precise digital terrain model, including areas covered by dense vegetation.	Detects microrelief features; penetrates vegetation; provides high-resolution data.	Expensive; requires complex data processing; limited in detecting subsurface structures.
Magnetometry	Measurement of variations in the Earth's magnetic field to identify archaeological anomalies.	Fast and non-invasive; efficient over large areas; detects walls, pits and kilns.	Ineffective in areas with high magnetic noise; limited detection depth.
GPR (Ground-Penetrating Radar)	Uses electromagnetic waves to detect subsurface structures and layers.	Provides profile images of stratigraphy; detects various materials; accurate in determining depth.	Low efficiency in clay-rich or wet soils; slower coverage of large areas.
ERT (Electrical Resistivity Tomography)	Measures the electrical resistance of soil to identify subsurface anomalies.	Effectively differentiates materials with varying moisture content; detects deep structures.	Requires good electrode-soil contact; time-consuming; sensitive to soil conditions.
Photogrammetry	Uses aerial or ground-based photographs to generate 2D and 3D models.	Relatively inexpensive; high visual resolution; suitable for documentation.	Limited in detecting subsurface structures; dependent on lighting conditions.
3D Modelling	Digital reconstruction of objects or terrain based on scans or photographs.	Enables visualisation and analysis; useful for presentation and conservation.	Lacks direct detection capability; dependent on input data quality.
Multispectral Analysis	Imaging in several spectral bands to identify materials and vegetation changes.	Reveals archaeological traces through changes in vegetation or soil colour; covers large areas.	Lower spatial resolution; dependent on atmospheric conditions.
Hyperspectral Analysis	Imaging in dozens or hundreds of narrow spectral bands for detailed surface analysis.	High capacity for material differentiation; detects subtle vegetation and soil changes.	Generates large data volumes; expensive equipment; complex processing.
Thermal Imaging	Detects surface temperature differences that may indicate subsurface structures.	Effective in detecting walls and pits; can be used at night.	Sensitive to weather conditions; limited spatial resolution.
GIS (Geographic Information Systems)	Software integration and analysis of spatial data from multiple sources.	Integrates all methods; enables spatial analysis and visualisation; supports decision-making.	Dependent on data quality and compatibility; does not directly detect structures.

Table 2. Overview of selected non-destructive methods currently available in archaeology.

of new methods can be expected in the future. Each method has a specific role in processing and interpreting spatial data. As technology advances, its capabilities will grow, increasing the potential for examining archaeological sites.

CONCLUSION

Although the concept of reflexive archaeology (Hodder 1999) did not resolve the methodological challenges posed by the destructive nature of excavation, and its application in practice fell short of the transformative change once envisioned, it nonetheless carved out a lasting space for critical reflection on the researcher's responsibility toward the material they uncover and interpret. That responsibility entails that archaeological interpretation must remain as open as possible to reconsideration, revision, and new questions, recognising that it cannot be based on a fixed and final body of facts, but on contextual, documented data that is itself always subject to rereading.

Despite significant advances in archaeological theory, contemporary practice still lacks a coherent methodological framework that unites an awareness of excavation's irreproducible nature with practical strategies for limiting destructive interventions. In response to this gap, this paper adopts Hodder's concept of reflexivity as a meta-framework for shaping a context-preserving approach, further informed by North American archaeological practice (Hanks and Doonan 2009).

Within this approach, we propose an operational model for archaeological research that combines traditional excavation with modern non-destructive techniques (LiDAR, magnetometry). Its application is demonstrated through the case studies of the sites of Kosa and Grivac. While the principle of limited excavation has been discussed internationally for decades, its practical application remains sporadic in Serbia. Therefore, the proposed model does not introduce an entirely new theoretical paradigm, but rather adapts and operationalises it within a context in which excavation still predominates both research and heritage management practices. In this way, we have shown that limited interventions can substantially increase the quantity and quality of evidence. At the same time, they expand the body of primary empirical data that remains available for future interpretations. By establishing clear criteria that determine both the appropriate timing and the underlying reasons for excavation, this paper offers a strategy that moves beyond declarative ethics and provides a practical framework for responsible archaeological practice. This approach makes a direct contribution to the current debate on integrating traditional and innovative methodological practices. The further development of this approach should be directed towards integrating data reuse and archival practices as an essential complement to the methodology of context preservation. In this sense, the long-term analytical life of archaeological data will not depend solely on the quality of its documentation and preservation, but also on the researchers' ability to recontextualize legacy datasets through future theoretical, methodological, and technological advances. Its aim is to ensure the greatest possible transparency and sustainability of archaeological knowledge, while safeguarding cultural heritage for future generations.

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REZIME

TEREN U PREISPITIVANJU: KA RAZVOJU ARHEOLOGIJE OČUVANJA KONTEKSTA NA PRIMERIMA STUDIJA SLUČAJA KOSE I GRIVCA U ŠUMADIJI

KLJUČNE REČI: ARHEOLOGIJA OČUVANJA KONTEKSTA, DESTRUKTIVNOST ISKOPAVANJA, NEDESTRUKTIVNE METODE, ARHEOLOŠKA DOKUMENTACIJA, PROVERLJIVOST PODATAKA

Osnovno polazište ovog rada zasnovano je na spoznaji o destruktivnoj prirodi arheološkog iskopavanja kao epistemološkom problemu koji nije adekvatno rešen unutar postojećih metodoloških okvira. Iako je koncept refleksivne arheologije, kakav je predložio Ijan Hoder, značajno uticao na promenu svesti o odgovornosti istraživača i otvorio prostor za kritičko preispitivanje postojećih interpretacija, u praksi nije ponudio konkretan metodološki odgovor na pitanje kako iskopavati bez nepovratnog gubitka konteksta. Polazeći od višedecenijskog iskustva

u arheološkim istraživanjima i zaštiti nasleđa, u radu se predlaže nov pristup zasnovan na lokalnom iskustvu, koji proizilazi iz „refleksivne" svesti i nastoji da prevaziđe njena metodološka ograničenja primenom nedestruktivnih metoda. Ovaj pristup se oslanja i na iskustva drugih arheoloških tradicija koje su razvile slične metode kao odgovor na različite istraživačke i kontekstualne izazove.

Kroz analizu rezultata istraživanja na lokalitetima Kosa i Grivac u Šumadiji, demonstriran je operacionalizovani pristup koji povezuje tradicionalne metode iskopavanja sa savremenim nedestruktivnim metodama kao što su LiDAR i magnetometrija. Reinterpretacija lokaliteta proizašla je ne samo iz novih saznanja dobijenih savremenim metodama već i iz kritičkog preispitivanja stare dokumentacije iz perspektive savremenih teorijskih i metodoloških pristupa. Na lokalitetu Kosa rezultati iskopavanja u kombinaciji sa analizom položaja naseobine ukazali su na postojanje gradinskog tipa naselja iz perioda eneolita. Nasuprot prvobitnom zaključku, novi rezultati LiDAR snimanja pokazali su odsustvo fortifikacionih elemenata i ukazali na to da je reč o naselju otvorenog tipa, bez odbrambenih struktura. Na osnovu arheoloških iskopavanja na lokalitetu Grivac zaključeno je da je na ovom prostoru tokom neolita postojalo više naselja zbijenog, ali otvorenog tipa. Međutim, kasnija magnetometrijska snimanja otkrila su jasno uočljiv sistem rovova duž oboda lokaliteta, što ukazuje da je naselje bilo zaštićeno odbrambenom strukturom. Dakle, saznanja dobijena primenom nedestruktivnih metoda dovela su do značajnih izmena prvobitnih interpretacija i otvorila nova pitanja, ne samo o organizaciji ovih lokaliteta kao zasebnih naseobinskih celina već i o njihovoj ulozi u širem sistemu istovremenih naselja.

Obe studije slučaja iz Šumadije jasno su pokazale da su nedestruktivne metode dale obimniji i raznovrsniji skup podataka za interpretaciju bez uništavanja inicijalnog konteksta. Iako tehnologije poput LiDAR-a i magnetometrije znatno unapređuju prostornu analizu lokaliteta, one ne mogu u potpunosti zameniti iskopavanja u prikupljanju stratigrafskih i hronoloških podataka. Stoga tradicionalna iskopavanja ubuduće treba sprovoditi u ograničenom i jasno fokusiranom obimu kako bi se dobili odgovori na precizno formulisana istraživačka pitanja. Ako se to ima u vidu, rad uvodi koncept arheologije očuvanja konteksta (*context-preserving archaeology*), koji se zasniva na jasno definisanim kriterijumima kada i zašto je iskopavanje opravdano, čime se izlazi iz okvira deklarativne etike i ulazi u domen metodološke odgovornosti. Ovaj pristup takođe prepoznaje i potencijal arhivske arheologije i ponovnog korišćenja postojećih podataka kao neophodnih dopuna dokumentaciji nastaloj tokom iskopavanja. Rad takođe ukazuje da arheološka praksa budućnosti mora da teži održivosti, odnosno da ostavi što više materijalnih tragova u „neistraženom" stanju, ali dokumentovanih i otvorenih za različite vrste daljih analiza i preispitivanja. U osnovi to podrazumeva ne samo usvajanje tehničkih alata već i promenu u epistemološkom odnosu prema terenu, podacima i interpretaciji. Integracija nedestruktivnih metoda u savremenu arheološku praksu ne postavlja se kao zamena za iskopavanje, već kao preduslov za njegovu precizniju i selektivniju primenu. Dalji razvoj ovog pristupa treba da bude usmeren na integraciju ponovnog korišćenja podataka i arhivskih praksi kao suštinska dopuna metodologiji očuvanja arheološkog konteksta.

Ključna vrednost predložene strategije jeste u njenom shvatanju istraživanja kao kumulativnog i odgovornog procesa. Umesto da arheološko znanje ostaje zatvoreno u jednom vremenskom i interpretativnom okviru, ovaj koncept podstiče proizvodnju znanja koje je otvoreno, ponovljivo i proverljivo. Rad time doprinosi širem teorijskom i praktičnom diskursu o transformaciji arheologije iz discipline koja „crpi" znanje iz prošlosti u disciplinu koja čuva potencijal znanja za budućnost. Na teorijskom nivou, rad zagovara prelazak sa reaktivne na proaktivnu arheološku etiku, koja ne deluje tek nakon intervencije, već je unapred uključena u proces donošenja istraživačkih odluka. Takav pristup podrazumeva finu ravnotežu između potrebe za naučnim saznanjem i dužnosti da se očuva što veći deo kulturnog nasleđa za buduće generacije. U tom smislu, arheologija očuvanja konteksta predlaže se kao paradigma koja premošćava dualitet između tehnike i etike, između interpretacije i očuvanja, i definiše arheologiju kao odgovornu humanističku nauku 21. veka.

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Use of tools based on large language models and generative AI: ChatGPT (translation); Grammarly (initial proofreading).

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AIR AND SOIL MICROBIAL CONTAMINATION IN ARCHAEOLOGICAL DEPOTS: POTENTIAL HAZARDS FOR PERSONNEL AND CULTURAL HERITAGE

ABSTRACT

Microbial contamination poses a major risk in archaeological depots, where dark, humid, and poorly ventilated environments promote fungal and bacterial growth, endangering both artifact preservation and human health. This study evaluated fungal contamination in air and soil from museum and laboratory depots to identify potential health risks for archaeologists, curators, and scientists. Due to decades of underfunding, many archaeological storage facilities remain in poor condition, often located in old buildings with inadequate ventilation and temperature control. The continuous introduction of organic material from excavations further enhances fungal proliferation. Air samples from two museums (National Museum of Zrenjanin, City Museum of Novi Sad) and two university laboratories (University of Belgrade - Faculty of Medicine and Faculty of Philosophy), along with soil samples from archaeological sites (Konopište, Remesiana), were analysed for cultivable fungi. The results revealed high fungal diversity, including pathogenic species such as Aspergillus fumigatus, A. flavus, Mucor spp., and Stachybotrys chartarum. Even partially renovated depots showed persistent contamination, suggesting infrastructure upgrades alone cannot mitigate biological risks. These findings emphasize the need for comprehensive renovation, biosafety protocols, and routine microbial monitoring to safeguard cultural heritage and staff. Future work should include CFU quantification from air, soil, and surfaces, along with epidemiological surveys and standardized prevention measures.

KEYWORDS: MUSEUMS, ARCHAEOLOGICAL DEPOTS, FUNGI, INFESTATION.

INTRODUCTION

Microorganisms such as fungi and bacteria are ubiquitous in both natural and man-made environments. These life forms usually thrive in dark, humid, and poorly ventilated spaces, conditions often found in archaeological depots (Niesler *et al.* 2010: 125–126; Skora *et al.* 2015: 389–390; Geweely 2023).

In such environments, organic materials (wood, textiles, and bone), as well as soil, dust and packaging material, provide ideal substrates for microbial colonization and proliferation. Their presence poses a risk not only to the preservation of archaeological artifacts, but may also represent a potential health hazard to staff who work in close or direct contact with contaminated materials,

such as curators, researchers, and students (Geweely 2023).

Exposure to moulds can cause a variety of health issues, ranging from allergic respiratory reactions to more serious conditions like pneumonitis and aspergillosis (Greenwood *et al.* 2007, Murray *et al.* 2021). Such health conditions are particularly dangerous for immunocompromised individuals (chemotherapy, immunosuppressive therapy, diabetes, or autoimmune diseases) (Greenwood *et al.* 2007: 45–55; Murray *et al.* 2021: 10–20). In these populations, exposure to moulds can lead to severe outcomes, including life-threatening systemic infections. Furthermore, exposure to bacteria in archaeological depots can also cause respiratory issues, skin infections, or gastrointestinal symptoms. In staff with weakened immune systems, it may lead to more severe infections, including bronchitis, pneumonia, or systemic illnesses (Viegas *et al.* 2022: 3–7).

In 2017-2018, a research project was carried out focused on the museological protection and bioanthropological analysis of human osteological material originating from archaeological sites in the Vojvodina region (Banat and Bačka).[1] During this period, the project team, accessed the depots of all relevant cultural institutions in the region[2] and gained direct insight into the condition of museum depots. Museums, and consequently their depots, are often hindered by a lack of financial resources and limited staffing. Many are situated in improvised areas like attics or basements, without proper ventilation, lighting, climate control, or the regular maintenance of packaging and storage conditions (Martinović i Jokić, 2009: 18–23). Most museum institutions have not undergone infrastructural improvements in decades. The neglect of museum facilities has put depots and staff at risk (Martinović i Jokić 2009: 24). They are exposed to dust, moisture, and deteriorating flooring, as well as to insects, rodents, and, often, pigeon infestations. Water leaks from old plumbing systems are common as well. Materials stored in old cardboard boxes can be affected by mould or covered in bird droppings (**Figure 1**). Overall, these dark, damp, and unsanitary conditions not only directly damage the cultural heritage of the Republic of Serbia but also pose serious health risks to curators and researchers.

Insights into the conditions of archaeological depots in Serbia prompted a pilot study in 2023/2024, focusing on the microbiological contamination of air and soil from archaeological excavations in museum and laboratory environments. Given that movable cultural heritage (bones, wood, pottery, stone, and metal objects) and samples (soil, plants, etc.) enter museum and laboratory archaeological departments directly from excavation sites with soil, the soil samples from archaeological excavations were also included in the analysis (**Figure 2**).

A multidisciplinary team, composed of researchers from the Infectious Diseases Clinic of the Clinical Center of Serbia, the Institute of Molecular Genetics and Genetic Engineering at the University of Belgrade, and the Center for Bone Biology at the University of Belgrade conducted a pilot study analysing the presence of cultivable fungi in soil samples from two archaeological sites and in air samples from two museums and two laboratory depots and offices, thereby indirectly assessing the potential health risks of exposure to such environments for archaeologists. The preliminary results of this study will be presented in this paper.

MATERIALS AND METHODS

Sampling in archaeological repositories and offices

Air contamination was assessed in several locations, including two faculty spaces and two museums. The faculty spaces were the Center for Bone Biology at the Faculty of Medicine, Belgrade and the Laboratory for Bioarchaeology at the Faculty of Philosophy, Belgrade. The museums

[1] *Museological protection and bioanthropological analysis of unprocessed human osteological material from the period of Antiquity from the sites on the territory of Banat and Bačka,* Grant no. 451-04-1776/2017-02, funded by the Ministry of Culture and Information of the Republic of Serbia (lead by Bečej City Museum and the Center of Bone Biology, Faculty of Medicine, University of Belgrade).

[2] National Museum of Pančevo, Vršac City Museum, National Museum of Zrenjanin, Bečej City Museum, Senta City Museum, Sombor City Museum, Subotica City Museum, Museum of Vojvodina, Provincial Institute for the Protection of Cultural Monuments.

Figure 1. An old box with archaeological material covered in bird droppings in the museum (Photo taken by Tamara Šarkić).

Figure 2. Conditions during archaeological excavations and soil sampling from the grave, Remesiana site (Photo taken by Tamara Šarkić).

included in the study were the Novi Sad City Museum and the National Museum of Zrenjanin. The analysis encompassed work offices and various types of storage depots. All units have large separate depots where materials are stored, typically located in basements and attics (**Figure 3**). The

Figure 3. The condition of archaeological storage facilities in museums: a. Museum depot in the attic, Novi Sad City Museum) (Photo taken by Tamara Šarkić); b. Museum depot in the basement, National Museum of Zrenjanin (Photo taken by Aleksandar Šalomon).

workspace may sometimes be an auxiliary depot (such as those at the Faculty of Philosophy and Faculty of Medicine) or an office where materials remain for a longer period. Only the Laboratory for Bioarchaeology and the Center for Bone Biology depots have been renovated in the past ten years, during which time archaeological materials were repackaged and reorganized into new boxes.

Archaeological soil sample collection

Fungi were cultivated from soil samples originating from two archaeological sites' soil; from the bottom of a grave at the site of Remesiana – in the Eastern Necropolis (excavations in 2020), from the Faculty of Philosophy; soil from an urn (sealed) from the site of Konopište (excavations in 1986), from the National Museum of Serbia. Soil samples from both sites were collected earlier by archaeologists during excavations and kept in packaging within archaeological depots (Faculty of Philosophy and National Museum of Serbia). In the case of the Remezijana site, archaeologists collected a larger quantity of soil from the bottom of the grave during fieldwork, intended for various types of later sampling and analyses. The soil was collected using spatulas and placed directly into zip-lock bags, then stored in plastic boxes in the depot. In the case of the Konopište necropolis, the soil was contained within a sealed urn, which had never been opened from the time of deposition until the bioanthropological study.

For fungi cultivation from soil, sterile equipment was used (gloves, masks, spatulas) to take 5 grams of soil from Remezijana and from the Konopište packaging, with each sample placed into separate zip-lock bags. Subsequently, Petri dishes were inoculated with 3 grams of soil from each sample.

Sampling and cultivation

The presence of fungi in the air and soil was assessed in all available samples. Fungi were cultivated on 14 Petri dishes containing Sabouraud Dextrose Agar (SDA) nutrient medium (composition per litre: 40 g dextrose, 10 g peptone, 15 g agar; pH 5.6 ± 0.2). The medium was commercially obtained from PROREADY – Ready to Use Culture Media, based in Serbia (Kikinda). After preparation, the plates were exposed to the air for 2 hours in archaeological depots to allow airborne fungal spores to settle, and then incubated for 7 days at 28 °C for fungal growth observation and microscopic identification at the Dr Milan Jovanović Batut Institute of Public Health.

The morphology, colour and pigment production of fungal colonies cultivated on the SDA were analysed macroscopically. A Leica DM500 light microscope (Leica Microsystems, Germany) was used for the microscopic analysis. To examine spore and hyphal morphology, lactophenol cotton blue stain was used to prepare slides. According to de Hoog *et al.* (2020) and Samson *et al.* (2014), the identification of fungal species was based on standard morphological criteria.

Since the study was intended to be a pilot qualitative screening of fungal diversity in archaeological depots using the conventional sedimentation method, CFU counting was not carried out. This method, which is frequently employed in environmental mycology, allows for the identification and detection of dominant fungal genera but lacks accurate quantification (Gorny and Dutkiewicz, 2002). In order to provide a more thorough microbial risk assessment, future research will include quantitative CFU/m³ determination, through volumetric air sampling and serial dilution plating of soil samples.

RESULTS

Air and soil samples contamination

The identification of fungal species in the samples revealed a large number of species commonly found in the air of storage and working spaces (**Table 1**). The most frequently present species in the storage rooms were *Aspergillus fumigatus* (in 6 depots), *Aspergillus flavus* (3 depots), *Mucor rhizopus* (3 depots), and *Cladosporium sphaerospermum* (3 depots). In the offices, *A. fumigatus* (in 4 offices) was the most frequently found species, followed by others **(Table 1).**

Partially renovated laboratories, such as those at the Faculty of Medicine and Faculty of Philosophy, still exhibited persistent fungal

SAMPLE CODE	LOCATION	FUNGAL SPECIES
LB1	Center of Bone Biology Small depot in the lab (ventilation, electric lighting); frequent entry	*Aspergillus fumigatus* (dominant) *Aspergillus flavus* *Alternaria alternata* Mucorales *Penicillium* sp. *Trichoderma* sp.
LB2	Center of Bone Biology Depot basement (no ventilation, electric lighting); sporadic entry	*Aspergillus fumigatus* *Aspergillus flavus* *Alternaria macrospora* *Cladosporium* sp. Mucorales *Paecilomyces* sp. *Stachybotrys atra*
LB3	Center of Bone Biology Depot on the second floor (no ventilation, electric lighting); rare entry	Mucorales *Aspergillus fumigatus* *Aspergillus niger* *Cladosporium* sp. *Fusarium* sp.
LB4	Center of Bone Biology Working space (windowed office); busy area	*Aspergillus fumigatus* *Aspergillus niger* *Penicillium* sp. Mucorales *Cladosporium* sp. *Paecilomyces* sp. *Stachybotrys atra*
LB 11	Laboratory for Bioarchaeology Office 2 (windowed space); busy area	*Mucor piriformis* *Aspergillus fumigatus*
LB 11a	Laboratory for Bioarchaeology Office 5 (windowed space); busy area	*Aspergillus fumigatus Aspergillus niger*
LB 11b	Laboratory for Bioarchaeology Chemistry room depot (no ventilation, electric lighting); frequent entry	*Rhizopus oryzae*
LB 16	Novi Sad City Museum Petrovaradin Depot attic (no ventilation, no windows); rare entry	*Mucor circinelloides* *Cladosporium herbarum* *Aspergillus flavus* *Aspergillus niger* *Aspergillus fumigatus*
LB 16b	Novi Sad City Museum Petrovaradin Office (windowed space); busy area	*Aspergillus flavus* *Aspergillus fumigatus*

Table 1. List of isolated airborne fungi.

SAMPLE CODE	LOCATION	FUNGAL SPECIES
LB 17	National museum of Zrenjanin Office (windowed space); busy area	*Aspergillus fumigatus Penicillium chrysogenum*
LB 17b	National museum of Zrenjanin Depot basement (no ventilation, electric lighting); sporadic entry	*Aspergillus versicolor* *Penicillium chrysogenum* *Stachybotrys chartarum*
LB 17c	National museum of Zrenjanin Depot attic (no ventilation, electric lighting); sporadic entry	*Aspergillus glaucus* *Aspergillus versicolor* *Aspergillus fumigatus* *Penicillium rubens* *Mucor racemosus* *Alternaria alternata*

Table 1. (Continued).

SAMPLE CODE	LOCATION	FUNGAL SPECIES
LB 5	Soil from site of Remesiana- East Necropolis, grave 16 (2020)	*Aspergillus fumigatus* *Aspergillus niger* *Alternaria macrospora* *Fusarium sp.* Mucorales
LB 6	Soil from site of Konopište, urn (1986)	*Aspergillus flavus* *Aspergillus fumigatus* *Aspergillus niger* *Penicillium* sp.

Table 2. List of isolated fungi from soil of archaeological sites.

presence, demonstrating that infrastructure improvements alone are insufficient to eliminate microbial contamination. Unrenovated depots, including the Novi Sad City Museum and the National Museum of Zrenjanin, displayed particularly high fungal abundance and diversity. Notably, species such as *Stachybotrys chartarum*, *Mucor circinelloides*, and *Aspergillus flavus* were identified.

The presence of fungi was observed in both soil samples **(Table 2)**. The following species were identified: *Aspergillus fumigatus* (2 soil samples), *Aspergillus niger* (2 samples), *Aspergillus flavus* (1 sample), *Penicillium* sp. (1 sample), *Alternaria macrospora* (1 sample), *Fusarium* sp. (1 sample), and *Mucor rhizopus* (1 sample).

DISCUSSION

Potential primary source of infestation - archaeological excavations

Archaeologists often work in extremely dirty and unhygienic environments and may be exposed to bacteria, fungi, and other potentially harmful microorganisms. In Serbia, field conditions are particularly challenging. Archaeologists typically work long hours outdoors, frequently in direct contact with soil, bone, and decomposing organic material, without basic protective equipment such as masks or gloves. This prolonged and unprotected exposure significantly increases the risk of microbial infections. The preliminary analysis of fungal samples from soil at archaeological excavations (grave and urn)

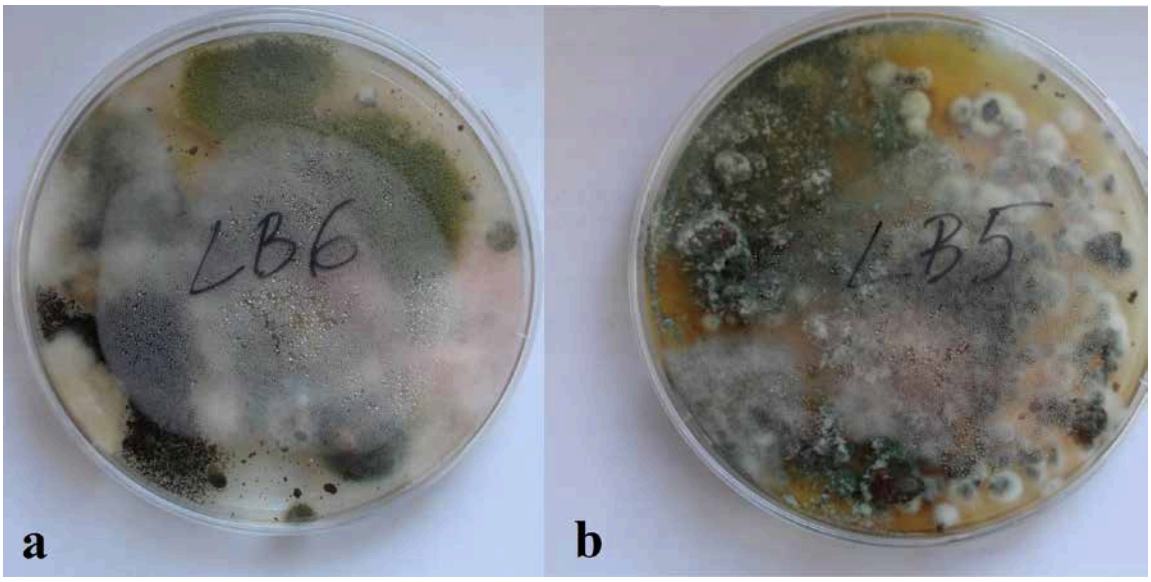

Figure 4. Mixed fungal cultures from soil samples: **a.** Konopište site, soil from the urn; **b.** Remesiana, soil from the grave (Photos taken by Tamara Šarkić).

revealed the presence of fungi (**Table 2**; **Figure 4 a-b**), which were also observed in the depots and offices (**Table 1**), suggesting a potential source and path of contamination.

This suggests a secondary health risk: after excavation, material stored in bags and boxes is transported to museum or university laboratory depots and offices. New "dirty" material arrives at depots where older material from the field is already stored, often in outdated and poorly maintained facilities, enabling the new material to come into contact with areas contaminated by the previously stored items (such as old cardboard boxes and dusty, humid spaces). Additionally, new microorganisms may be introduced into the space each time new materials are brought into it, further increasing the overall pollution of the storage space.

The state of museum depots in the Republic of Serbia

Many museums in Serbia suffer from decades of neglect, with no major infrastructural renovations and dusty and humid depots (Martinović and Jokić 2009). Due to the difficult financial situation in the country, museums generally lack the necessary budgets for depot renovation or for purchasing new, clean storage containers, all of which can act as a vector of pathogen transmission (Wißmann *et al.* 2021: 343). Limited funding has also led to a persistent lack of qualified personnel in most museums (Crnobrnja 2017: 90–91), which in turn causes depots to become overcrowded with archaeological material, primarily from earlier excavations, which remains unprocessed and inadequately stored. Over time, the cardboard boxes used for storage begin to deteriorate, making them structurally unstable and even more susceptible to microbial contamination. Also, due to the lack of staff, depots are rarely adequately cleaned. Furthermore, since many depots are located in old basements or attics without proper sealing, ventilation, or pest control, small animals such as rodents (rats, mice or dormice), mammals (weasels), and birds (pigeons) frequently enter these spaces. They leave droppings and nesting materials on and around the storage containers, creating additional sources of contamination and increasing the health risks for anyone working in these environments. Pipes in the basement storage areas (depots) often crack, leading to flooding in the spaces where material is kept. Meanwhile, the attic storage depots can experience structural damage, such as roof collapses, which exposes them to rain, snow, and bird infestation. These conditions could not only jeopardize the cultural heritage but also pose ongoing threats to the health and safety of archaeological staff.

On the other hand, the situation at university faculties is somewhat more favourable. This is primarily because faculties generally have more staff and greater funding, which enables at least partial renovation of offices and depots. As a result, some archaeological material has been repacked and reorganized, and storage spaces have been cleaned and repainted (**Figure 5)**. However,

Figure 5. Examples of renovated depots and arranged boxes containing archaeological material: a) Center for Bone Biology, Faculty of Medicine, Belgrade; b) Laboratory for Bioarchaeology, Faculty of Philosophy, Belgrade (Photos taken by Tamara Šarkić).

despite these improvements, these areas still house old archaeological material (bones, wood and organic material) that cannot be fully cleaned or disinfected due to their fragile or organic nature. This ongoing risk is supported by the findings from our study, because even in laboratories that have undergone renovation (Faculty of Medicine, Faculty of Philosophy), the presence of fungal contamination was detected. For example, in the depot of the Center of Bone Biology, we identified *Aspergillus* sp., *Alternaria alternata, Mucor* sp., *Stachybotrys* sp., *Paecilomyces* sp., *Cladosporium* sp., and *Fusarium* sp. (**Figure 6a**), which could all be harmful for immunocompromised persons (Greenwood *et al.* 2007; Murray *et al.* 2021). A similar situation was detected in the Laboratory for Bioarchaeology at the Faculty of Philosophy, where *Mucor* sp., *Aspergillus* sp., *and Rhizopus oryzae* were found (**Figure 6b**). In these two instances, the renovation of the depot space and repackaging in plastic boxes did not completely remove the fungi.

Unreconstructed storage depots that are in poor condition, such as those at the National Museum of Zrenjanin and the Novi Sad City Museum, show a high concentration and diversity of fungi in the air (**Table 1**). For example, in the depot of the Novi Sad City Museum, which is situated in an attic with a collapsed roof, *Mucor circinelloides*, *Aspergillus flavus*, and *Aspergillus fumigatus* were identified, all highly pathogenic. In the depot of the Zrenjanin museum, *Stachybotrys chartarum* (black mould) was detected, which can cause respiratory issues, chronic fatigue, headaches, and irritation of the eyes, nose, and throat when inhaled in indoor environments (Greenwood *et al.* 2007: 30–45; Murray *et al.* 2021: 12–18). Thus, colleagues responsible for this collection face health risks each time they enter the depot. This contaminated environment is especially hazardous for them if they have currently weakened immune systems or acute health issues.

Furthermore, analysis of the air in the offices confirmed the presence of various pathogenic species of fungi, which suggests that the offices in museums and laboratories are also contaminated—most likely due to the introduction and temporary storage of boxes from previously polluted depots. The areas where depots are integrated with offices are particularly noteworthy, as exemplified by the Center of Bone Biology, where a small ventilated depot constitutes a separate section of the room. In the working area, we identified *Aspergillus fumigatus (dominant), Aspergillus niger, Penicillium* sp., *Mucor (Rhyzopus), Cladosporium* sp., *Paecilomyces* sp., *and Stachybotrys atra*.

Potential health risks associated with detected fungal species in archaeological depots

Several fungal species identified in both the depot and office environments are recognized as potentially hazardous to human health, particularly in cases of prolonged exposure and poor ventilation, which is the case with archaeological depots and immunocompromised individuals. *Aspergillus fumigatus* was the most frequently detected species and is known to be one of the leading causes of invasive aspergillosis, a serious respiratory infection primarily affecting immunocompromised individuals (Greenwood *et al.* 2007: 40–50; Murray *et. al* 2021: 15–22). It can also produce asthma and cause allergic bronchopulmonary aspergillosis. *Aspergillus flavus* poses a dual threat, as it can cause opportunistic infections and is capable of producing aflatoxins (Greenwood *et al.* 2007: 35–50; Murray *et al.* 2021: 14–22). *Aspergillus versicolor*, although less frequently encountered, produces sterigmatocystin, another mycotoxin with carcinogenic potential, and can trigger allergic reactions (Greenwood *et al.* 2007: 32–45, Murray *et al.* 2021: 13–20). Also, *Stachybotrys chartarum*, commonly referred to as "black mould," is particularly concerning in indoor settings due to its production of trichothecene mycotoxins, which have been associated with respiratory symptoms, chronic fatigue, and irritation of the mucous membranes (Greenwood *et al.* 2007; Murray *et al.* 2021). *Alternaria alternata*, another frequently isolated species, is a well-documented airborne allergen implicated in asthma and allergic rhinitis (Greenwood *et al.* 2007; Murray *et al.* 2021). Several species of *Mucor* (e.g., *M. rhizopus*, *M. circinelloides*, *M. piriformis* and *M. racemosus*) have also been detected and are capable of causing mucormycosis, a rare but aggressive fungal infection affecting the sinuses, lungs, or skin, primarily in individuals with weakened immune defences or uncontrolled diabetes (Greenwood

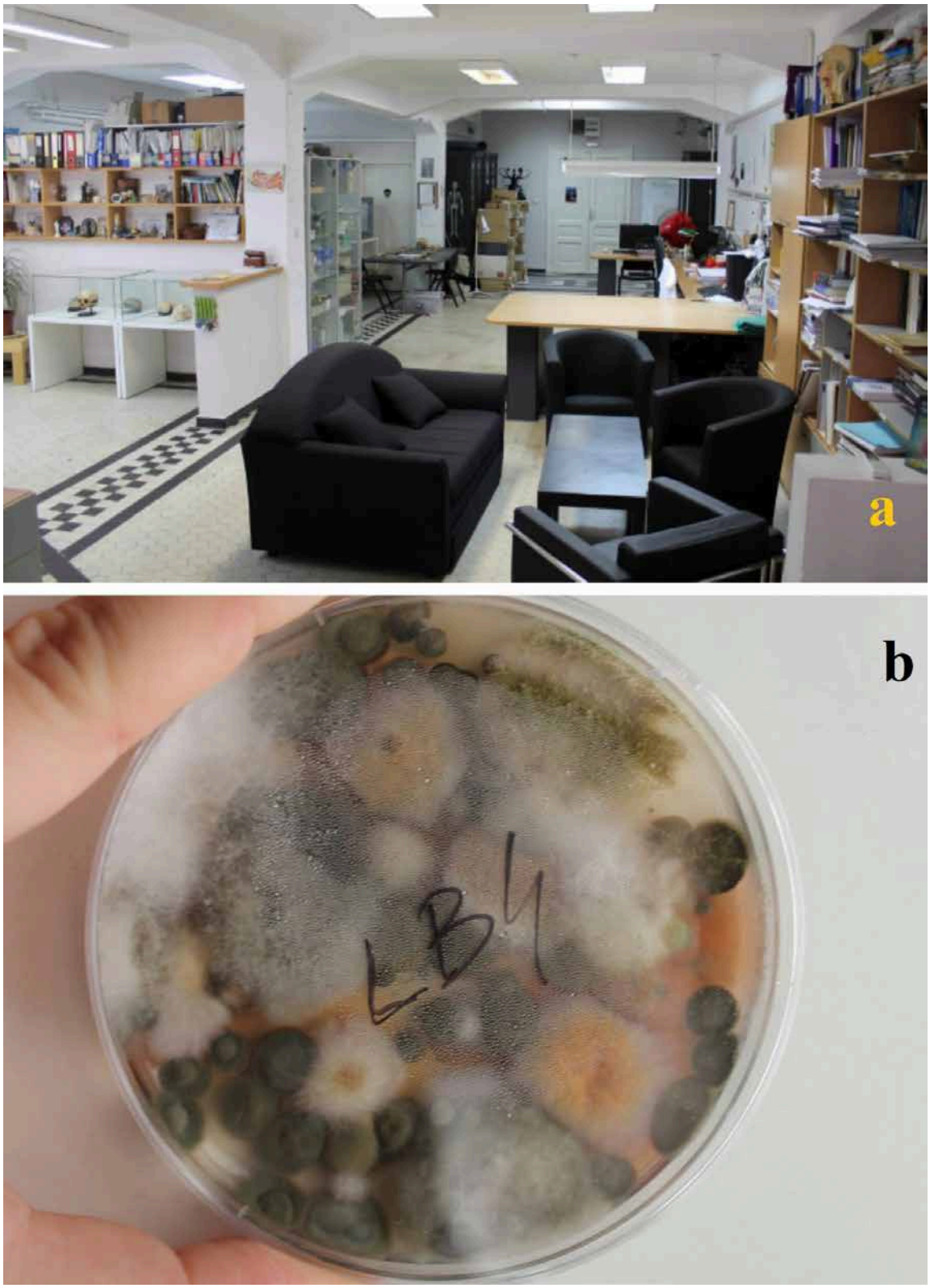

Figure 6. Representation of the sampled laboratory environment: **a.** Archaeological depot integrated into the workspace (office), Center of Bone Biology; **b.** Mixed fungal cultures in the office and working air, Center of Bone Biology (Photos taken by Tamara Šarkić).

et al. 2007, Murray *et al.* 2021). *Fusarium* spp., though less frequently found, are capable of producing harmful mycotoxins and can cause superficial and systemic infections, particularly in immunocompromised patients. *Aspergillus niger*, commonly associated with otomycosis (fungal ear infections), may also contribute to respiratory issues (Greenwood *et al.* 2007: 25–40; Murray *et al.* 2021: 10–18).

Other isolated species, such as *Trichoderma* sp. and *Aspergillus glaucus* are typically regarded as of low medical relevance, but may still cause irritation, allergies, or localized infections in rare cases (Greenwood *et al.* 2007: 45–55; Murray *et al.* 2021: 18–25). Collectively, the presence of these fungal species in indoor working environments underscores the importance of maintaining proper ventilation, controlling humidity, and implementing regular environmental monitoring to minimize occupational exposure and to protect public health. Future studies will use bacteriological cultures and molecular characterization to assess the entire spectrum of microbial contamination, including bacteria known to cause skin and respiratory infections in laboratory and museum personnel, even though bacterial isolates were not included in the current phase.

Worldwide, recent studies on health risk and the recommended threshold for health and safety continue to apply the guideline values of 750 CFU/m³ for bacteria and 150 CFU/m³ for fungi, originally derived from Italian MiBAC standards, as reference limits for museum and heritage environments (Saridaki *et al.* 2023; Katsivela *et al.* 2021). Comparable recommendations exist elsewhere, such as Swedish practice allowing up to 500 CFU/m³ for bacteria and 300 CFU/m³ for fungi. However, these thresholds are not universally accepted or scientifically validated across all contexts, due to differences in material sensitivities, species-specific risks, and methodological variations (Pinheiro *et al.* 2019). Importantly, neither the World Health Organization (WHO) nor the International Committee of Museums (ICOM) provides firm, globally accepted microbial threshold standards for museum or heritage settings (World Health Organization 2009; ICOM-CC and IIC 2014). Despite the lack of CFU quantification, the qualitative method made it possible to identify potentially harmful species that are important for evaluating occupational risk. In accordance with WHO guidelines for indoor air quality, future research will use quantitative techniques for both bacterial and fungal CFU counts.

For a more precise assessment of potential health risks in the future, comprehensive quantitative analyses would be necessary, including CFU counts, expanded sampling campaigns, and epidemiological surveys among personnel working in archaeological depots and offices. This study, for now, represents a pilot investigation and an initial step toward developing more comprehensive guidelines for assessing microbiological risks in archaeological depots. The analysis was based on screening of microbial cultures present in air and soil samples, without any quantitative assessment of colony-forming units (CFU). However, at present, universal standards for microbial contamination control in museums and related institutions are lacking. As highlighted by Pinheiro *et al.* (2019), existing thresholds are mostly defined at a national level and are based on occupational health criteria rather than conservation considerations. These limits seldom differentiate between microbial species with distinct risk profiles or account for the varying sensitivities of heritage materials. Moreover, much of the existing literature focuses mainly on airborne fungal contamination within archives and libraries (Pinheiro *et al.* 2019), while studies on museum environments are far less common (Di Carlo *et al.* 2016; Madsen *et al.* 2025). Such contexts differ significantly from archaeological depots, where organic materials retrieved from the soil, often uncleaned and stored for decades, create unique microbiological and conservation challenges. This distinction is especially relevant in the case of Serbian archaeological depots, where storage conditions further emphasize the need for context-specific approaches and tailored standards.

CONCLUSION

This pilot study highlights the significant biohazard risks faced by archaeologists and museum personnel due to exposure to old and unrenovated, contaminated depots and

workspaces, as well as during archaeological excavations. The findings confirm that inadequate infrastructure, lack of protective equipment, and poor hygienic conditions in the institutions could create a continuous chain of microbial contamination, especially by pathogenic fungal species. Even in the partially renovated spaces included in the study, airborne fungi such as *Aspergillus fumigatus*, *Aspergillus flavus*, and *Mucor* spp. persist, posing health risks, particularly for immunocompromised individuals. The situation is especially critical in unreconstructed storage depots, with old boxes, poor ventilation, rodents, and birds exacerbating fungal proliferation. Air analyses from offices and shared depot/work spaces further suggest potential cross-contamination from previously stored archaeological materials in offices. Even these preliminary results highlight the need for systematic renovation, the implementation of biosafety protocols, and regular environmental monitoring in both museums and research institutions. However, to accurately assess the extent of microbial contamination and its health implications, further systematic studies involving a larger number of institutions are essential.

It is important to emphasize that the detected fungal contamination should not be interpreted as a direct consequence of inadequate management by museum personnel. The causes of biodeterioration and contamination are complex and multifactorial, involving interrelated factors such as limited financial resources, the organization of management structures, and the coordination of tasks among institutions responsible for the protection of cultural heritage. This study indicates that the primary sources of contamination most likely originate from the excavation sites themselves, where soil and organic materials are inherently exposed to microbial colonization. Therefore, an effective preventive strategy requires the joint effort of archaeologists, conservators, curators, and laboratory specialists to establish integrated protocols that ensure both occupational safety and the long-term preservation of cultural heritage.

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REZIME

KONTAMINACIJA VAZDUHA I ZEMLJIŠTA SPORAMA GLJIVA U ARHEOLOŠKIM DEPOIMA: POTENCIJALNI RIZICI ZA OSOBLJE I KULTURNO NASLEĐE

KLJUČNE REČI: MUZEJI, ARHEOLOŠKI DEPOI, GLJIVE, KONTAMINACIJA

Arheolozi u Srbiji često rade u teškim i zdravstveno rizičnim uslovima. Dugotrajno izlaganje zemljištu, raspadajućem organskom materijalu, kao i ljudskim i životinjskim ostacima, najčešće se odvija bez osnovne lične zaštitne opreme. Ovakva praksa znatno povećava rizik od infekcija izazvanih mikroorganizmima, naročito bakterijama i gljivama. Preliminarne mikološke analize potvrdile su prisustvo potencijalno patogenih gljiva u uzorcima zemljišta sa arheoloških nalazišta, naročito iz grobova i urni. Iste vrste gljiva su identifikovane u zatvorenim prostorima, uključujući muzejske depoe i laboratorije, što ukazuje na jasno definisan put kontaminacije od terena ka radnim prostorima.

Nakon iskopavanja, arheološki materijal se transportuje u depoe muzeja i laboratorija, koji su često loše održavani. Dodatni je problem nedostatka osoblja u muzejima. Brojni muzejski objekti nikada nisu renovirani, što utiče na nedostatak ventilacije, povišenu vlažnost, i prisustvo životinja (ptica, glodara) u depoima. Materijal se često čuva u dotrajalim kartonskim kutijama, u prašnjavim i vlažnim uslovima, što pogoduje razmnožavanju gljiva. Dodatni rizik predstavlja unošenje novog materijala, što povećava mogućnost unakrsne kontaminacije i akumulacije mikroorganizama.

Cilj studije bio je procena fungalne kontaminacije vazduha i zemljišta u muzejskim i laboratorijskim depoima i identifikacija potencijalnih zdravstvenih rizika za arheologe. Analizirani su uzorci vazduha iz dva muzeja i dve univerzitetske laboratorije, kao i zemljište sa dva arheološka lokaliteta, za prisustvo kultivabilnih gljiva. Rezultati su pokazali visok nivo raznovrsnosti gljiva u depoima i kancelarijama, uključujući patogene vrste poput *Aspergillus fumigatus*, *Aspergillus flavus*, *Mucor* spp. i *Stachybotrys chartarum*.

Iako su univerzitetske kolekcije u boljem stanju, kontaminacija je i dalje prisutna. U Centru za biologiju kostiju Medicinskog fakulteta i Laboratoriji za bioarheologiju Filozofskog fakulteta detektovane su gljive *Aspergillus* spp., *Mucor* spp., *Alternaria alternata*, *Cladosporium* spp., *Fusarium* spp. i *Paecilomyces* spp., sve potencijalno štetne za ljudsko zdravlje. Iako su obe laboratorije nedavno rekonstruisane, a materijal u depoima u najvećoj meri prepakovan, one ostaju kontaminirane.

Analize vazduha pokazale su da spore gljiva nisu ograničene na depoe, već se šire i u radne prostore, izlažući zaposlene stalnim rizicima. Infrastrukturna obnova depoa nije dovoljna. Ovi rezultati naglašavaju potrebu za sistematskom obnovom, biosigurnosnim protokolima i redovnim mikrobiološkim nadzorom radi zaštite kulturnog nasleđa i osoblja. Buduća istraživanja trebalo bi uključiti kvantifikaciju CFU iz vazduha, zemljišta i kontaktnih površina (kutije i pokretni materijal), u kombinaciji sa epidemiološkim ispitivanjima i standardizovanim preventivnim protokolima radi sveobuhvatne procene profesionalnih i konzervatorskih rizika.

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MULTIMODAL MEANINGS AND DIGITAL CULTURE: A CRITICAL STUDY OF THE COOLTOUR PLATFORM

ABSTRACT

This paper presents a theoretical and analytical study of the digital platform COOLTOUR, developed as a model for participatory learning about cultural heritage through multimodal practices within the eponymous international project. The paper aims to use multimodality as a research methodology, to gain a more complete understanding of the platform model in the aspects of communication and education, which should be used to recreate, improve, or innovate upon the platform design and, thus secure its analytics. Drawing upon the theories in social semiotics, modal affordances, intermedial analysis, and critical digital pedagogy, the study positions the platform not merely as a tool for knowledge transfer but as a dynamic landscape of meaning in which users become both producers and interpreters of cultural heritage narratives. The empirical evaluation of the platform encompasses an analysis of student participation during the project, as well as the structural modalities and pedagogical design of meaning. Particular attention is devoted to how textual, visual, spatial, and interactive modalities interweave, as well as to the limitations evident in the auditory and haptic layers. The study affirms the potential of the platform as a model of an innovative pedagogical ecosystem that acknowledges the role of young users as active cultural heritage agents in the digital sphere.

KEYWORDS: MULTIMODALITY, METHODOLOGY, COOLTOUR PLATFORM, CULTURAL HERITAGE, COMMUNICATION, DIGITAL PEDAGOGY.

INTRODUCTION

Project *COOLTOUR – Millennials for Cultural Heritage*, funded by the Erasmus+ programme of the European Union, was implemented between 2022 and 2024,[1] with the goal to foster dialogue between young people and professionals in the field of cultural heritage, resulting in two main outputs: the *COOLTOUR* digital platform and a set of guidelines for cultural heritage managers. Both were developed after the close identification of the target group, which, from the project's application preparation, evolved from general

[1] The project ID: 2021-1-IT03- KA220-YOU-000029203. The *COOLTOUR* project gathered cultural heritage professionals, universities, research and cultural management institutions, communication experts, and millennial organizations from six European countries. Partner institutions included the *Associazione Enti Locali per le Attività Culturali e di Spettacolo* (IT), the Institute of Archaeology and the Archaeology Students' Club (SRB), the *Študentska organizacija Univerze v Ljubljani* (SLO), the Cyprus University of Technology (CY), Brodoto (CRO), and the *Association of Cultural Heritage Managers* (HU).

millennials (Gen Y and Gen Z together), to young millennials i.e., Gen Z during the lifespan of the project implementation.[2]

In the previous issue of the journal *Archaeology and Science*, the authors of this paper presented *COOLTOUR* project as its participants and co-creators, and its platform as a case study of inverted education – digital natives (students from Gen Z – young millennials) teaching digital immigrants (teachers and heritage managers belonging to older generations) about the contemporary and effective ways of cultural heritage communication for young generations as its users (Anđelković Grašar *et al.* 2024, 159–173). Starting from this case study, the authors realized that the digital platform expanded the project's initial idea and general result, thus becoming a model/prototype for an engaged and participative digital solution that was set up according to the needs and preferences of the young focus group. To prove this thesis, the authors perceived the *COOLTOUR* platform model through the theoretical lenses of a multimodal methodology, applied retrospectively to a platform whose design was not originally guided by such an approach. Rather than informing the platform's original design, this paper adopts a multimodal analytical framework to examine how the already developed platform integrates multiple modes of communication, such as texts, images, videos, sounds and gestures, to create meaning and educational purpose.

Recent scholarly research and peer-reviewed academic studies reinforce this interdependence of design and meaning. Petrovski *et al.* (2024) argue that digital heritage platforms should be approached not as static repositories but as cultural interfaces in which spatial form, aesthetic configuration, and user participation jointly produce interpretive possibilities. Such environments, they note, foster situated and relational encounters with heritage, where meaning emerges through the interplay of perception, movement, and agency. This perspective resonates strongly with the *COOLTOUR* platform, where the case study serves less to assess the project itself than to validate the analytical approach through which its meaning-making capacities become visible.

From a humanities points of view, multimodality as the applied methodology is used for the authors' clearly subjective dialogic introspection (Burkart 2018, 167–190). This process involves critical self-awareness, where the authors reflect on the final results of the project they were directly involved in and on the collaborative work with developers. This collaboration led to the achievement of one of the project's main goals – the *COOLTOUR* platform, which, from this exclusively theoretical point of view, proved to exceed its initial purpose. On the other hand, the digital solution itself applies theories of multimodality similar to the process of reverse engineering (Raja 2008, 1–3), which analyse a finished product in order to understand its design, construction, or functionality by working backward from the final form. Thus, acquired knowledge can be used to recreate, improve, or innovate upon the original design, and the provided analyses should prove or improve the *COOLTOUR* model, by opening up the possibility to re-establish secure funding of the *COOLTOUR* platform online or allow its model to be re-used and replicated in future international initiatives.

Against this background, the aim of this paper is to examine the *COOLTOUR* platform as a multimodal and participatory digital environment, and to clarify how its design and narrative structures support meaning-making among young users. The central problem addressed here is the lack of analytical research on youth-oriented digital heritage tools that function not only as repositories of cultural content but as epistemic spaces in which knowledge is co-constructed through multimodal interaction. Accordingly, this study explores: How does multimodal design enable or constrain interpretation? In what ways does the platform support participatory cultural authorship? How does *COOLTOUR* compare with existing multimodal heritage platforms in terms of narrative openness and user agency?

Although research on digital heritage is growing, it generally seems that youth-oriented participatory platforms remain underexplored, particularly from a multimodal and model-making perspective. This paper, therefore, contributes a

[2] Preliminary research conducted by the Heraclitus Research Center (Cyprus University of Technology) provided essential insights into the millennial generation and their relationship with cultural heritage (Cooltour 2021a).

focused examination of *COOLTOUR's* multimodal architecture and participatory affordances, clarifying its educational potential and its position within contemporary youth digital practices. Taken together, these insights position the *COOLTOUR* platform into a broader transformation of cultural heritage education, in which digital environments, user agency, and experiential engagement play a growing role in shaping how young audiences encounter and interpret the past.

MATERIALS AND METHODS

The paper relies on a theoretical-methodological approach that does not treat digital platforms as neutral technological tools, but as spatial-medial formations in which meaning is generated through the interplay of modalities, discourse, and user interaction. Instead of a classical evaluation of user experience or technical functionality, the focus of this study is on the semiotic and epistemological dynamics of digital design—on how the interface, medial forms, and narrative structures collectively produce meaning and shape the user's cultural experience.

Heritage education and interpretation in digital environment

In the contemporary digital environment, education in cultural heritage is compelled to address the complex challenges of engagement, accessibility, and semantic relevance. Traditional models of knowledge transfer, grounded in linear, textually dominant, and passive didactics, are proving increasingly ineffective when confronted with generations growing up within the conditions of so-called post-alphabetic literacy (Prensky 2001, 1–6; Cope and Kalantzis 2020b). These generations, as *digital natives* (Prensky 2001: 1–2), operate within networked, visually saturated, and interactively structured learning landscapes. Within this framework, the concept of multimodal literacy has moved to the forefront of educational theory: the idea that meaning is not inherent to any single modality (for instance, text), but instead emerges in the dialogue between modalities—visual, textual, auditory, interactive, and gestural—and the socio-cultural practices that frame them (Kress and van Leeuwen 2001; Bezemer and Kress 2016). Multimodality is, thus, not treated as the mere use of multiple media, but is the coordinated orchestration of diverse meaning-making resources in an educational context.

In this context, the significance of digitization in the field of archaeology and the preservation of cultural heritage becomes twofold: on the one hand, as a tool for documenting, conserving, and disseminating material heritage, and on the other, as a site of epistemological transformation. Contemporary authors such as Jeffrey (2012: 553–570) emphasize that digital archaeology does not merely entail the conversion of physical artifacts into 3D models or databases, but also demands reflection on how digital representations shape narratives of the past and transform the relationship between archaeological practice and the public. Gillings and Morgan (2017) further point out that digital tools are not neutral infrastructures, but active agents that influence modes of interpretation and experiential engagement with heritage.

As Huggett (2020: 105–119) observes, digital technologies enable the development of new models of interpretation that are open, non-linear, and participatory, making them particularly suited to engaged forms of cultural production and collective memory. Such an approach creates a space for narrative fusion and shared meaning, thereby destabilizing the traditional distinction between experts and laypersons in favour of more inclusive and dialogical approaches. In this light, digital archaeology emerges as a field of convergence between technology, archaeological knowledge, and cultural subjectivity, in which digital tools function as interpretative agents rather than mere technical instruments.

The *COOLTOUR* platform was divided into the "Heritage" segment, where data on sites and institutions is entered, and the "Community" segment, where users generate and exchange digital content. Through this structure, the platform opens a space for hybrid forms of cultural heritage interpretation. As stated in the project's mission, *COOLTOUR* represents a fresh approach to cultural heritage, aiming to strengthen the relationship between Gen Z and heritage sites, while fostering dialogue between youth and the professionals managing them (Dankovics 2023). Its value cannot lay merely in technical functionality, but rather in its capacity

to generate new forms of meaning through the interaction of professionals and the public, of expert and lay knowledge, of local and global experience. The results of international and national pilot programmes have demonstrated that the *COOLTOUR* platform can function as a meaning-oriented ecosystem and a pedagogical framework in which young people emerge as active agents of cultural heritage reinterpretation and new narratives production. (Anđelković Grašar *et al.* 2024: 191–206). In a parallel vein, Lai *et al.* (2025, 1–22) demonstrate that the creation and circulation of multimodal cultural artefacts enable young users to articulate ethnocultural identities and assume narrative authorship. Their study confirms that engagement with heritage in digital environments is not a passive form of consumption but an active, socially embedded practice of meaning-making, shaped by aesthetic, relational, and participatory forms of expression. Based on the theoretical ground, the *COOLTOUR* platform is better understood as an interpretive matrix in which meaning emerges through user navigation, selection, and experiential engagement. However, rather than a landscape of meaning, it is an educational environment whose primary function is not the dissemination of knowledge but the construction of meaning. It operationalizes multimodal educational strategies through the integration of textual, visual, auditory, and interactive components, ranging from factual descriptions and mapped routes to user-generated video recordings. In this sense, the *COOLTOUR* platform functions as a model of designed model production, where knowledge emerges in the interplay between modes and user interpretation.

Theories interrelated

The theoretical foundation of the paper rests on four interrelated paradigms that enable a multi-layered analysis of the relationship between media, knowledge, and culture:

1. The theory of modal affordances (Bezemer and Kress 2016) – which interprets modalities as resources endowed with specific semiotic potentials within given contexts;
2. Models of multimodal coherence (Bateman and Wildfeuer 2014: 180–208) – which examine the degree of integration of modalities into meaningful wholes;
3. Intermedial analysis (Elleström 2010a: 11–48) – which elucidates how meaning is transformed across media forms;
4. Critical digital pedagogy (Cope and Kalantzis 2020b) – which shifts the focus from the transmission of content to the design of meaning as the foundation of the educational process.

First and foremost, *the theory of modal affordances* (Bezemer and Kress 2016) allows the analysis of modalities not as aesthetic choices, but as culturally encoded resources of meaning. Each modality—whether text, image, sound, movement, or interactive component—possesses specific potentials for semantic articulation that are not universal, but contingent upon technical, social, and institutional contexts. This theory helps illuminate how specific design choices (e.g., horizontal versus vertical scrolling, icons, pictograms, and the placement of text in relation to images) shape how users perceive and interpret content.

Second, *the models of multimodal coherence* (Bateman and Wildfeuer 2014: 180–208) provide instruments for analysing the integration of multiple modalities within a unified space of meaning. Multimodal coherence presupposes the presence of different modalities and their integrated functioning within narrative, semantic and rhythmic harmony. These models enable the identification of points of alignment and dissonance within the digital narrative, as well as the detection of potential weaknesses in the platform's construction of meaning through multiple modalities.

Furthermore, *intermedial analysis* (Elleström 2010a: 11–48) enables the examination of how meaning circulates between different media forms—for example, how a physical archaeological site is transformed into a digital artifact/environment, or how a museum narrative is recoded through video, mapping, or VR simulation. Intermediality does not simply denote the combination of multiple media; it also

researches the ontological differences between them and the ways in which these media alter the structure and perception of meaning. Within the scope of this paper, intermedial analysis facilitates the exploration of the complexities of representing cultural heritage in a digital environment, including the risks of semantic reduction and the potential for narrative expansion.

Finally, *critical digital pedagogy* (Cope and Kalantzis 2020b) underscores the need to view digital educational practices not as the mere transmission of content, but as processes of meaning design that engage users as active participants in the construction of knowledge. This perspective enables the analysis of the digital platform not as a closed system, but as an open space for participation, reinterpretation, and the sharing of knowledge—an aspect of crucial importance when it comes to cultural heritage and the rights of communities to shape their own narratives (**Figure 1**).

On this basis, the digital educational platform is not regarded as a technical tool, but as a communicative and pedagogical framework in which modalities are interdependent, and meaning is grounded in context, interaction, and the engagement of users. Text is not hierarchically privileged over images or videos, and each modality possesses its own distinct semantic function.

Contemporary research on digital heritage further supports this theoretical orientation. Bekele *et al.* (2021) demonstrate that immersive and interactive environments activate distinct epistemic pathways through which users co-construct, rather than receive, cultural meaning. Similarly, Koutromanos and Koukopoulos (2023, 3513–3536) show that participatory heritage-education platforms position learners as contributors to the design and interpretation of digital content, thereby transforming knowledge from a transmissive model into an iterative, shared practice. These findings reinforce the

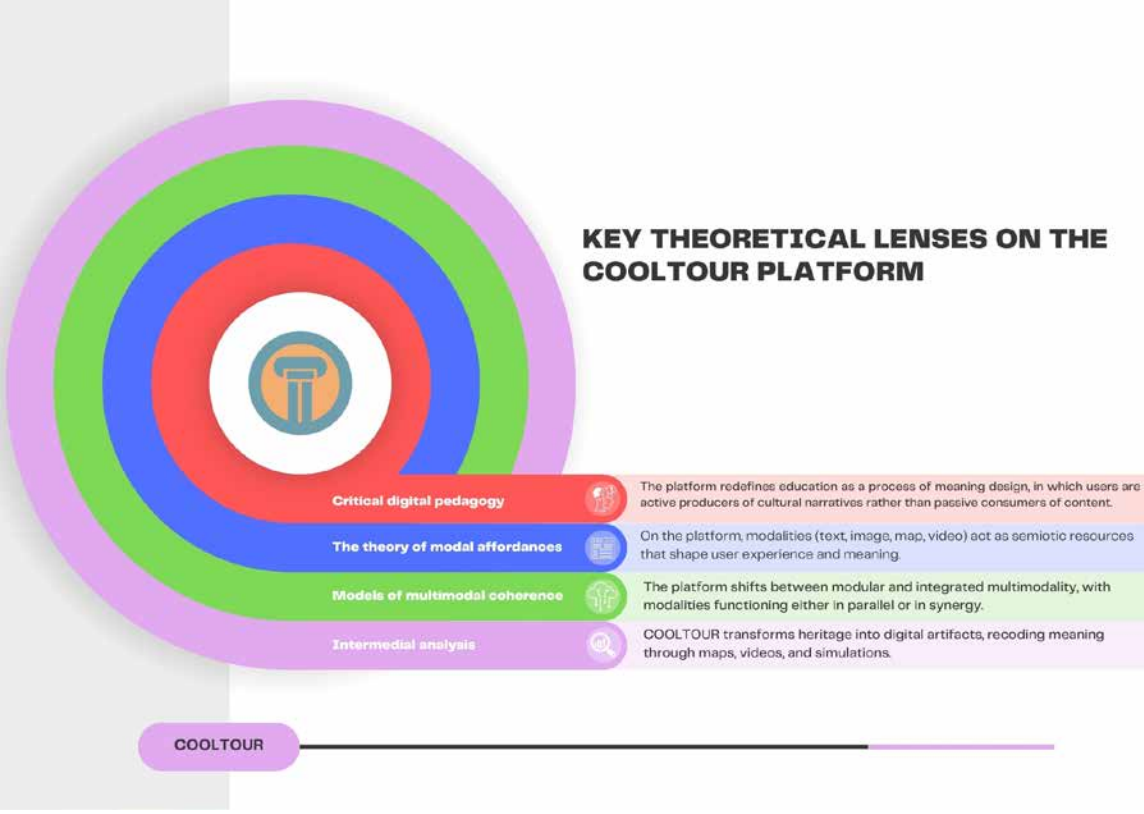

Figure 1. Key theoretical frameworks informing the analysis of the *COOLTOUR* platform, emphasizing their specific contributions to understanding its multimodal structure, participatory dynamics, and epistemological implications (created by the authors).

analytical premise adopted in this paper: that digital heritage systems operate as interpretative and relational environments in which meaning emerges through relational, collaborative, and multimodal engagements.

Platform experience and practice

In addition to this theoretical grounding, an important methodological reference point for the present analysis arises from findings of earlier research conducted within the same project framework. That study examined how the *COOLTOUR* project's educational activities shaped the interpretive practices of young participants, particularly during international mobility programmes. Rather than treating heritage learning as the reception of predefined information, the research showed that young users engaged with heritage through a constellation of multimodal practices—photographs, short videos, audio notes, and reflective micro-narratives—often developed collaboratively in mixed-nationality teams (Anđelković Grašar *et al.* 2024: 167–169).

What emerged was evidence of how learners gain knowledge and a better understanding of how they create cultural meaning. This includes how they select, frame, organise, and narrate experience when they have access to different signs and symbols. The findings show that participants relied on combining visual, textual, auditory, and performative cues to structure their interpretations and articulate personal narratives. Current research supports this direction. Lucena Rodríguez *et al.* (2021, 13–27), in their systematic review, demonstrate that digital storytelling fosters identity work, reflexivity, and active cultural engagement, positioning learners as agents rather than recipients of meaning. Likewise, recent studies in digital education highlight that collaborative, multimodal narrative practices—whether digital stories, reflective micro-narratives, or hybrid audio-visual compositions—enhance interpretive depth and foster heightened sensitivity to cultural difference. These findings resonate strongly with the dynamics observed in the *COOLTOUR* project, in which narrative co-creation serves as a catalyst for deeper engagement and culturally situated understanding.

Taken together, these insights indicate that modal affordances—visual, textual, auditory, and gestural—function as pedagogical mechanisms that shape perception and interpretation rather than merely transmitting information. This earlier research, therefore, provides a methodological bridge for the present study. It shows that the analytical potential of the *COOLTOUR* platform cannot be assessed independently of the experiential and participatory contexts in which young users have already demonstrated their capacity to act as observers, interpreters, and authors of cultural narratives. In this sense, the platform does not appear as an isolated technological product but as a structured continuation of practices validated in real educational settings. These insights form the conceptual grounding for the present analysis, which examines the platform not through its technical features but through the cultural and knowledge-related conditions under which it generates meaning.

* * *

From a methodological perspective, the analysis of the *COOLTOUR* platform will be conducted as a qualitative-interpretive study that relies on a critical reading of digital elements and their meaning-producing functions within an educational context. Rather than quantifying elements, the emphasis is placed on understanding the mechanisms of meaning that emerge from the interdependence of modality, technology, and cultural context. The interface is approached as a visual and interactive narrative, whose elements—colour, typography, spatial positioning, sound effects, animation, navigation rhythm, and functions—operate as signifying resource codes.

While the platform has not yet achieved full coherence among its visual, textual, and interactive modalities, it nonetheless reveals an emergent tendency toward intermodal synthesis—a process in which meaning arises through the interplay rather than the isolation of media forms. In certain instances, visual and textual components still function as parallel signifying systems, without producing a unified semantic field, and some video materials or interactive modules remain peripheral to the central narrative logic. Yet, these discontinuities should not be read as mere technical shortcomings, but as indicators of an

ongoing epistemological experiment in which knowledge is negotiated, rather than transmitted. The *COOLTOUR* platform, thus, gestures toward a pedagogical model grounded in the *design of meaning*—a participatory and reflexive process through which users become active agents in the co-production of cultural narratives and the reinterpretation of heritage within digital space. This study departs from the assumption that digital multimodal literacy is not merely a supplement to traditional education, but rather its transformative foundation within the contemporary social context.

The study applies a qualitative procedure based on three components: an interface walkthrough of the *COOLTOUR* platform to identify its multimodal and navigational structures; a comparative review of selected digital heritage platforms using criteria from modal affordances and participatory design; and an interpretive reading of user-generated materials from mobility activities as illustrative evidence of meaning-making. Such an approach positions the digital platform as an active epistemic construct where identity, memory and cultural belonging emerge through the interaction of modalities rather than through the accumulation of discrete informational units. The applied theories, therefore, do not evaluate the platform in terms of technical efficiency, but illuminate the semiotic, conceptual and social conditions that shape how cultural knowledge is produced and negotiated within its digital environment.

RESULTS

Building on the previously established theoretical framework, this section analyses the specific functionalities and narrative structures of the *COOLTOUR* platform, with a focus on modal integration, intermedial dynamics, and participatory potentials.

Review of existing multimodal platforms

To situate the position of this platform more precisely and exactly within the given theoretical approach, it will be compared with two good practice multimodal models in digital heritage—*Europeana* and *Google Arts & Culture*—which offer different approaches to interpreting and digitizing cultural heritage, but yet do not depend on project-based financing and possible online closing

Europeana represents the European Union's digital platform, whose aim is to consolidate and make accessible the cultural heritage of European organisations to a broader public (Europeana). With more than 50 million digitized objects, including images, texts, videos, and audio recordings, *Europeana* functions as both an archival and educational database, yet largely remains faithful to a linear, textually dominant model of representation. The visual component often serves an illustrative rather than an interpretative role, while user interaction remains limited. Although the platform supports various formats, such as exhibitions, thematic collections, and blog entries, its narrative potential rarely transcends the framework of traditional museological discourse.

In contrast, *Google Arts & Culture* relies on the power of digital technologies (e.g., gigapixel photography, virtual tours, AR experiences) to provide immersive and visually rich encounters (Google Arts & Culture). The platform employs an interactive and multimedia approach; however, its algorithmic logic and corporate framework often shape access to content, at the expense of contextual and critical insight. The emphasis is placed on spectacle and accessibility, while user participation remains limited to consumption rather than the production of knowledge.

Taken together, these platforms illustrate the dominant paradigms of digital heritage representation, comprehensive aggregation on the one hand, and technologically enhanced visual immersion on the other; however, they fall short of fully developing participatory, locally oriented, and epistemologically reflexive dimensions. This gap opens the space for an analysis of the *COOLTOUR* platform as a potential model that introduces new forms of meaning negotiation, collective interpretation, and educational multimodality. It should be emphasized that, unlike *Europeana* and *Google Arts & Culture*, the *COOLTOUR* platform does not aim to compete in terms of technological sophistication, metadata infrastructure, or advanced visualization capabilities. Its value lies elsewhere: in its

participatory orientation, youth-centred design, and openness to local narrative production. In this sense, *COOLTOUR* complements rather than replaces large-scale digital heritage platforms, operating within a different pedagogical register.

Media complexity and user agency of the COOLTOUR platform

In the field of digital cultural heritage, the pedagogical and conceptual force of a platform does not reside in its content alone, but in the specific configurations through which multiple media forms converge to shape experience. What, therefore, requires critical attention is not simply the presence of diverse modes but how they are orchestrated into structures that enable or constrain interpretation, affect, and participation. Multimodality, in this sense, functions as an architecture of meaning: a patterned distribution of sensory, spatial, and symbolic resources that conditions how users encounter, negotiate, and ultimately construct cultural knowledge.

Within this analytical horizon, the *COOLTOUR* platform can be understood not as a collection of discrete media elements, but as a composite semiotic environment whose analytical and conceptual potential arises from the interplay of its material, perceptual, spatial, and narrative features. This perspective provides the ground for examining, first, the material conditions that enable and constrain meaning on the platform. From a material perspective, the platform operates on a stable and accessible technical foundation. The interface is simple yet functional, offering a responsive design, intuitive navigation, and clear content organization, in line with the basic principles of digital usability.

In contrast to large-scale platforms such as *Europeana* and *Google Arts & Culture*, *COOLTOUR* does not match their technical sophistication, metadata infrastructure, or advanced visualization capabilities - a high degree of adaptability in terms of user display, including personalization of colours, contrast, font size, or the inclusion of a night mode. Its comparative value, therefore, lies not in technological superiority but in its participatory orientation, multimodal emphasis, and youth-focused design. This distinction highlights that *COOLTOUR* operates within a different epistemic and pedagogical register, complementing rather than competing with established digital heritage platforms.

The aspects that pertain to accessibility and universal design extend beyond technical issues and are directly connected to the ethics of digital education and the question of who can access meaning, how, and under what conditions (Selwyn 2010: 65–73). As the theory of modal affordances emphasizes (Bezemer and Kress 2016), the interface does not represent a neutral environment. However, it actively constitutes the frames of meaning through what it offers as well as what it excludes. In this sense, the lack of user personalization restricts not only the aesthetic experience, but also the cognitive and affective engagement of different types of users—particularly those with specific sensory needs—thus raising the issue of digital inclusivity.[3]

Perceptually, the *COOLTOUR* platform is clearly visually oriented, which is hardly surprising given the context of digital cultural interfaces that rely on the representational potential of images. Photographs of sites, iconographic symbols, infographics, and panoramic views shape the user experience through a visual dramaturgy based on well-known models of visual communication (van Leeuwen 2005). However, the absence of ambient sounds, auditory guides, and haptic effects reveals the limited modal diversity of the platform. As Bateman and Wildfeuer (2014: 180–208) emphasize, multimodal textuality presupposes the integration of multiple sensory layers that operate in relation to one another and interweave in the construction of meaning. Thus, while *COOLTOUR* relies on visual appeal, it remains partially confined within the framework of monomodal dominance, which can weaken the affective dimension of learning—particularly for users who respond more effectively to auditory or kinaesthetic modes of learning. In this sense, expansion of the modal repertoire would enhance the platform's aesthetic capacity and support

[3] The concept of Universal Design for Learning (UDL) entails the creation of digital environments that enable equal participation for all users, regardless of their physical, cognitive, or social specificities. The absence of personalization options can, thus, become a barrier rather than a neutral technical decision (CAST 2024)

deeper semantic immersion through a richer sensory dramaturgy.

In the dimension of spatial-temporal navigation, the *COOLTOUR* platform achieves some of its most significant pedagogical accomplishments. Users are enabled to independently choose thematic routes, sequences of content, and their own pace of engagement, thereby opening a space for individualized and reflective learning. In contrast to traditional educational systems that rely on the sequential flow of knowledge, here the logic of hypertext is activated—a networked structure of meaning that allows multidirectional movement and semantic leaps (Landow 2006). The interactive maps within the platform do not just serve as spatial markers. They also act as a narrative tool that integrates space, narration, and interpretation. In this sense, they correspond to what Anne Cranny-Francis (2005) describes as *spatial narratives*, where topography and meaning are not separated but co-created: movement through space is simultaneously movement through meaning. The positioning of users within a panoramic map of the site enables the spatial performativity of knowledge—an approach based not on acquisition but on interpretation in both real and digital space. The non-linear structure of the platform supports what Cope and Kalantzis (2020b) term *a personalized flow of learning*, in which the user does not "follow" knowledge but "configures" it. Such an architecture of knowledge supports constructivist models of learning, where knowledge emerges from the interaction between prior experience and new content (Vygotsky 1978), while also affirming participatory pedagogy, since the user actively chooses their narrative trajectory, thereby being positioned as a subject rather than an object of education. Moreover, this structural openness makes possible the formation of micro-curricula tailored to users' specific interests, transforming the platform into a tool for polycentric education—that is, an education not grounded in a single "correct" path of learning, but in a multiplicity of parallel interpretive trajectories. This positions the *COOLTOUR* platform as a producer of spaces of meaning, not only through content, but also through the very architecture of access to that content.

From an analytical perspective, the platform articulates multiple modalities—textual, visual, spatial, and, to a lesser extent, auditory—into structured units of meaning. It is crucial to emphasize that these modalities do not function as isolated informational channels, but as semiotic resources with their own logics of signification (Kress 2010). Photographs of heritage sites, for example, function as visual narratives, coded through local symbols, colour schemes and spatial contexts, thereby evoking specific cultural and affective connotations. Digital maps and infographic symbols shape what may be called cognitive metaphors of space (Lakoff and Johnson 1980), insofar as they position the user, both physically and epistemologically, as a subject who "sees" knowledge through mapped orientations.

User-generated video narratives introduce *personalized voices* and enable *intercultural narration*—that is, a meaning-making practice in which subjective experience becomes a legitimate interpretative mode. Nevertheless, it is evident that semantic synergy among modalities is not always fully achieved. In specific segments, visual elements remain decorative without contributing functional meaning, while textual components are often presented as separate informational units, unaligned with the visual or auditory layers. This situation can be explained through the distinction between modular and integrated multimodality (Bateman and Wildfeuer 2014: 180–208). In a modular structure, modalities coexist but are not coordinated, whereas in an integrated structure, all modalities jointly produce meaning that exceeds the sum of their individual parts. In this sense, the platform oscillates between the two poles. Although it offers high flexibility in expressive modalities, insufficient intermodal coherence in specific segments reduces both the affective and cognitive efficacy of learning. As van Leeuwen (2005) notes, successful multimodal communication requires *the coordination of semiotic chains*, in which each modality contributes to a common semantic goal. When this does not occur, *semiotic noise* emerges, hampering interpretation and diminishing engagement.

In pedagogical terms, such a situation opens a space for critical curatorship, where content designers (whether institutional teams or the users themselves) are tasked with improving existing elements through *remediation* (Bolter and Grusin 2000) and establishing stronger intermodal

connections. Rather than a static architecture, the *COOLTOUR* platform can cultivate what might be called *a dialogue of modalities*, in which modalities complement, counterpoint, and activate reflection. Such dynamics would contribute to semantic depth and foster the formation of new literacies—visual, digital, and media—that are crucial to the contemporary educational context. Beyond its technological and perceptual aspects, the platform's key pedagogical and conceptual value lies in its capacity to affirm user agency. Users are, thus, not positioned as passive recipients of ready-made knowledge, but as active interpreters and co-authors of meaning, thereby transforming education from a transmissive into a participatory process. This dynamic is grounded in constructivist theories of learning, particularly in the work of Seymour Papert (1980), who argued that knowledge emerges through *active construction* rather than *passive acquisition*.

Likewise, in the spirit of participatory culture (Jenkins 2009), the platform enables users to assume creative control over the processes of digital production, reinterpretation, and distribution of cultural narratives. A concrete example of this dynamic can be observed in the projects carried out during student mobility at the Viminacium archaeological park, where participants created visual maps of the site, video recordings captured on mobile devices, and memes that combine contemporary humour with historical references. This content did not merely serve as an illustration of existing material but instead shaped *authentic youth narratives* that reinterpret cultural heritage through the language and aesthetics of contemporary generations.

In this way, the *COOLTOUR* platform fosters digital literacy while shaping the cultural agency of its users, enabling them to become producers of meaning rather than mere consumers of content. Such practice decentralizes the authority of knowledge and creates a space for an emancipatory digital pedagogy in which the user becomes an epistemological subject— the one who negotiates meaning in relation to their own position, affinities, and cultural experience. In this context, the platform should not be regarded as a closed informational system, but as an open semantic environment, a dynamic field in which meanings, positions, and interpretive possibilities continually shift in response to user engagement. Visual metaphors, images, iconographic symbols, graphic elements, and compositional relations within the interface play a particularly important role in this meaning-making process. In line with Forceville's interpretation, visual metaphors serve not only to represent concepts but also to encode identity positions, values, and cultural distinctions. In the case of the platform in question, visual compositions function as structured meaning-making devices that shape the user's emotional and cognitive orientation toward cultural heritage. The interface therefore operates as a form of visual dramaturgy, in which meaning is produced through the arrangement of elements, iconographic symmetry, and narrative aesthetics.

User experience as situated meaning-making: Empirical insights

Against this backdrop, insights from the *COOLTOUR C1 learning mobility* further demonstrate how meaning on the platform arises not through the passive reception of predefined content but through users' situated interpretive labour, embodied engagement, and collaborative negotiation.[4] Evaluative data indicates that once participants navigated tasks, interacted with peers, and anchored their observations in concrete experiences, especially during on-site workshops, the platform acted as a catalyst for interpretive autonomy, affective investment, and collective authorship. Across the cohort (ages 18–24), this dynamic materialised in three interwoven forms of agency: *interpretive agency*, visible in the capacity to frame personal narrative connections; *affective agency*, marked by enjoyment, curiosity, and heightened motivation; and *participatory agency*, reflected in users' willingness to collaborate, negotiate perspectives, and generate cultural content.

[4] The quantitative and qualitative findings discussed in this section are based on internal evaluation data documented in the *C1 Mobility Agenda in Viminacium – Evaluation of Non-Formal Learning Activities*, developed within the *COOLTOUR* project. The document synthesizes participant self-assessments, qualitative reflections, and aggregated evaluation results collected during the C1 learning mobility activities.

Quantitatively, the strongest indicators emerge precisely in the domains tied to meaning-making: 92% of participants reported strengthened interpersonal and communicative competences, including active listening and initiative; 92% affirmed improved ability to participate in peer-to-peer learning environments; 80% reported enhanced digital and communication skills; 92% noted an increased awareness of cultural diversity; and 75% experienced a greater sense of European belonging. This data suggests that what animates learning in this context is not the transmission of heritage information but the orchestration of interpretive situations—moments in which users synthesise visual, textual, and social cues into culturally situated meaning. (**Figure 2**)

Qualitative responses reinforce this tendency. Participants repeatedly described the activities as "a different way of thinking about stories," "more collaborative than school learning," or "a way to understand people through their experiences." Such statements indicate not simply a positive reception but a restructuring of the pedagogical environment: from linear consumption to distributed sense-making. From a contemporary learning perspective, the platform becomes a *design space of meaning*—an environment in which learning arises through the assembling, recombining, and recontextualising of semiotic resources, grounded equally in perception, interaction, and cultural positioning.

Particularly revealing were the reflections linked to the activities conducted at the Viminacium Archaeological Park. Participants emphasised that the physical encounter with the site, combined with tasks requiring documentation, narrative reframing, and cross-cultural collaboration, enabled the production of what they called "authentic stories" and "a more personal connection with culture." This resonates with theoretical accounts of site-specific spectatorship and with research in digital pedagogy that positions place, movement, and embodied attention as catalysts for affective and cognitive synthesis. In these contexts, multimodality becomes inseparable from situatedness: learning occurs through the convergence of spatial, sensorial, and symbolic registers.

Taken together, these insights position the *COOLTOUR* platform within broader transformations in cultural heritage education, where digital environments and user agency increasingly shape how young audiences encounter the past. The data reveals that participants do not simply consume heritage narratives; they rehearse forms of authorship, testing how cultural meaning can be constructed, negotiated, and communicated through multimodal operations. This empirical layer consolidates the theoretical argument advanced so far: meaning on the *COOLTOUR* platform does not pre-exist user engagement; rather, it arises through the activation of modal, spatial, and interpretive possibilities embedded in its design. When users navigate, record, compare, or collaboratively articulate their observations, the platform functions less as a database of discrete information and more as a meaning-making apparatus, an environment in which cultural knowledge is enacted rather than delivered. The convergence of design structures and user agency thus reveals the platform as a pedagogical system whose epistemological force lies in the ways it enables, shapes, and delimits interpretive practice.

A ***critical reading of the COOLTOUR platform as a meaning-making artifact***

Digital platforms for cultural heritage increasingly function not as containers of information but as knowledge-oriented environments: spaces in which meaning is shaped through the interplay of design, modality, and user participation. Within this broader conceptual shift, the *COOLTOUR* platform cannot be approached through the conventional logic of e-learning systems, which presuppose linear progression, hierarchical instruction, and the passive reception of knowledge. Instead, its architecture positions users within an interpretative environment in which interpretation, navigation, and creative production constitute the primary modes of engagement. The platform, thus, demands a critical reading informed by theories of multimodality, intermediality, and design epistemology, approaching it not as a functional tool but as a cultural artifact that stages the very conditions under which knowledge becomes thinkable. Viewed from this perspective, *COOLTOUR* emerges as a dynamic assemblage, a mediated environment in which meaning unfolds through movement, interaction,

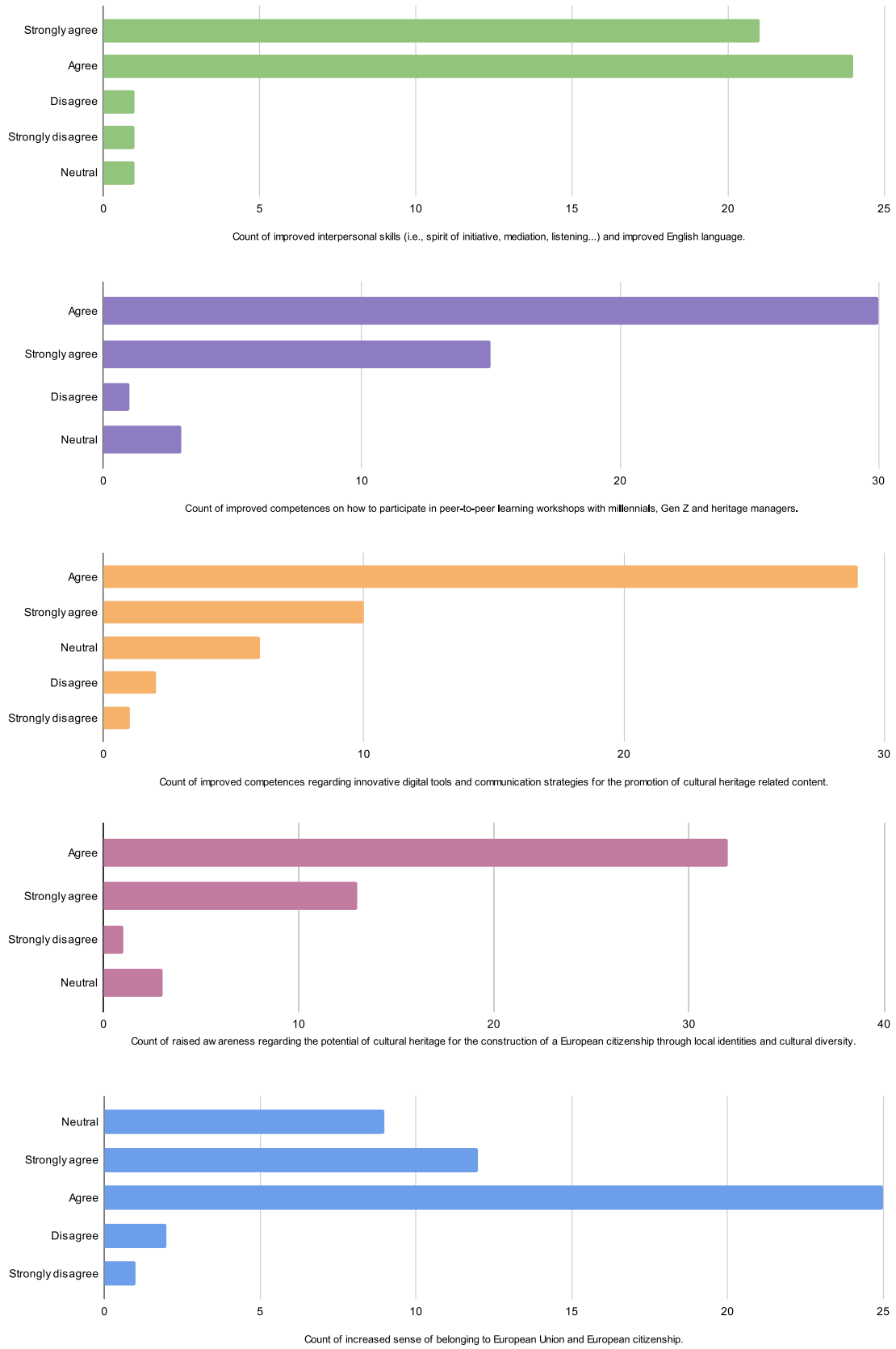

Figure 2. Quantitative indicators of learning impact among COOLTOUR participants during the C1 learning activities.

and perceptual attention. In line with Lemke's interpretation of digital texts, the platform operates as a semantically fluid system that emerges through movement: through selection, navigation, reinterpretation, and interactive use. The platform does not present itself as a finished repository of knowledge but as a space of its constitution—as a digital dramaturgy of meaning in which the user actively constructs their own trajectory of understanding. The platform's visually minimalist interface carries a strong cognitive and semiotic function. In the spirit of Norman's (2005) theory of design affordances, it shapes the user's modes of thought, engagement, and perception, whilst also enabling technical navigation. The absence of narrative explicitness and the uncluttered design of the interface invite the user to take an active role in constructing meaning, rather than remaining passive reader. In this sense, the interface acts as a framework of potential meanings rather than a container of finished content.

Of particular importance for the platform is the multimodal architecture of its content: photographs, digital maps, iconographic symbols, and videos are not decorative layers of text, but modalities of meaning that articulate the affective, cultural, and cognitive dimensions of user experience (van Leeuwen 2005). In line with the concept of modal affordances, each modality carries a specific potential to encode meaning through its materiality, thereby enabling a layered weaving of signification.

One of the most significant examples of participatory dynamics is the practice of creating video narratives by young users. Their technical informality—recording with mobile devices, using dialectal language, and employing experimental editing—does not constitute a deficiency, but a deliberate expressive strategy that reflects the values of participatory culture (Jenkins 2009). These recordings become performative digital ethnographies, merging the personal, the local, and the cultural into unique narrative forms. In this context, visual metaphors assume a key cognitive function. As Forceville (2017: 26–41) emphasizes, visual metaphors extend beyond the representation of concepts to encode identity positions and cultural affinities.

The interface of the *COOLTOUR* platform, thus, functions as an iconographic system in which colours, layout, symbols, and compositional relationships shape the user's emotional and semantic orientation. A relevant example is the profile of the *Belgrade Institute for the Protection of Cultural Monuments*, created during a pilot programme in collaboration with students from the University of Belgrade (**Figure 3**). The cover's visual composition—a turquoise statue of one of Belgrade's most known symbols – Pobednik (The Victor), set against a black-and-white panorama of Belgrade Fortress—constructs a metaphor of the encounter between past and present, as well as of the active preservation of heritage within the contemporary digital space. The dominant turquoise hue of the statue sets the tone of the entire image, directing the user's attention toward the cultural artifact that stands as a visual marker of identity, while the hashtag #*RCPR* (*Research – Collect – Protect – Respect*) functions as a visually branded emblem, rooted in the language of young users, which incorporates the functions of the institution into the form of an identity-based digital mark. As such, the *RCPR* acronym becomes a semiotic condensation point, a fusion of institutional discourse and the linguistic practices of younger users. This combination of graphic design, narrative economy, and participatory semantics represents, as Forceville would suggest, a visual metaphor of cultural mission, encoded in a form that is emotionally resonant, mnemonically effective, and cognitively orienting. In this sense, the interface design functions as a dramaturgy of meaning, in which every element—image, word, colour, and layout—is employed in articulating the values that the platform embodies.

This practice, in which educational, institutional, and aesthetic layers intertwine, confirms Bezemer and Kress's (2016) claim that the design of meaning is always socially positioned: the choice of modalities, their arrangement, and their intensity are not neutral, but constitute strategies of articulating meaning. The platform thus does not function as a digital showcase, but as an open system of meaning—a space in which knowledge is not "transmitted" but constituted through dialogue, interpretation, and visual production. In this case, the decision to use an acronym in the form of a hashtag (#*RCPR*)

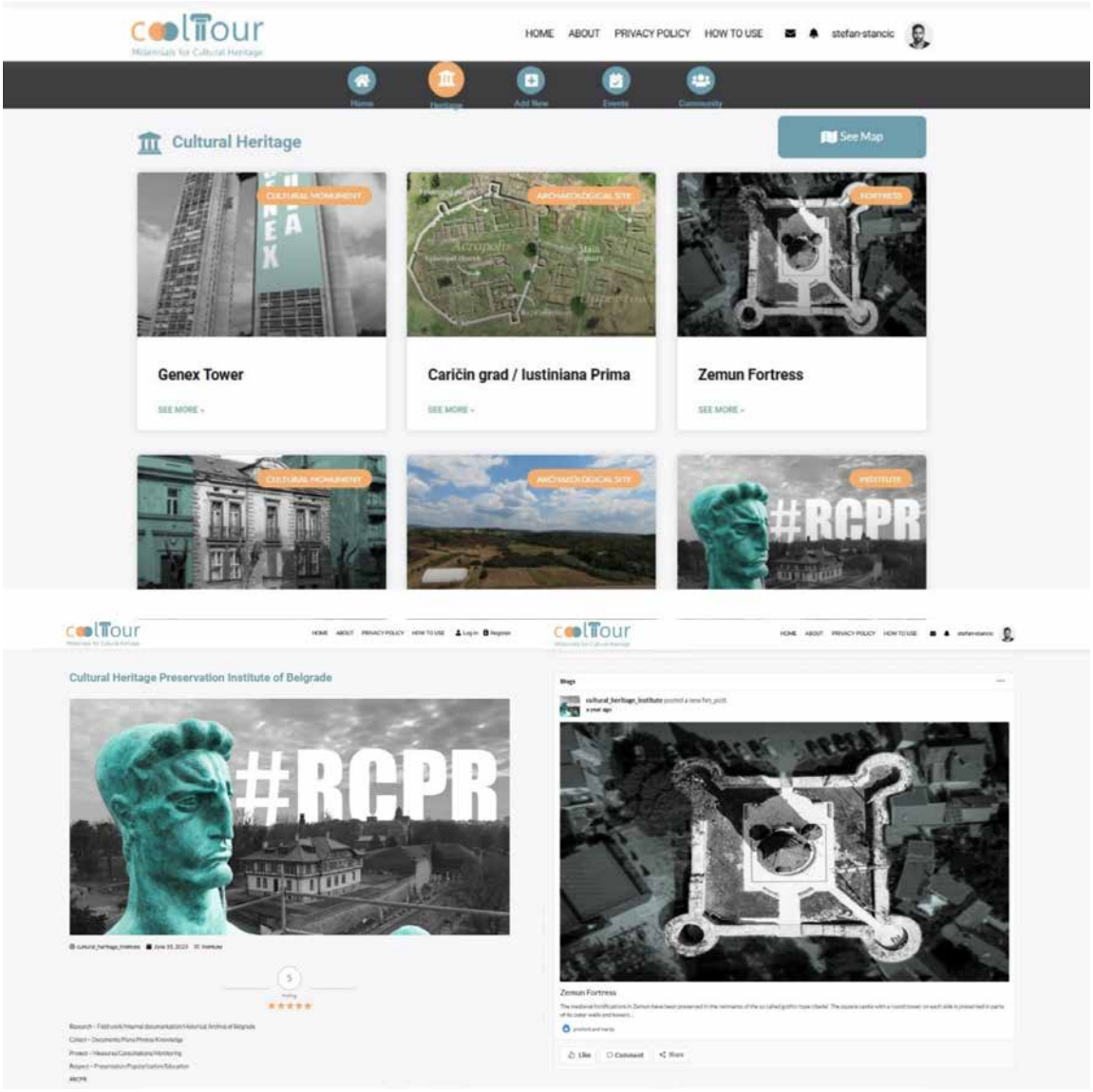

Figure 3. Visual layout of the Heritage section of the COOLTOUR website (top), showing the hierarchical structure of navigation — from the profile of the Institute for the Protection of Cultural Monuments of Belgrade (bottom left) to one of the heritage sites under its care, Zemun Fortress (bottom right) (collage made by the authors using *COOLTOUR* website screenshots - https://cooltourproject.com, accessed on August 4th 2025).

testifies to both the platform's embeddedness within contemporary digital culture and an attempt to bridge cultural policy with the language of younger users.

DISCUSSION

Multimodal pedagogy and digital culture

In examining the pedagogical implications of the *COOLTOUR* platform, it becomes evident that its educational value cannot be understood through conventional models of digital instruction. Rather, it is realised through the practices the platform enables, where learners actively construct meaning across modalities. The student mobilities implemented within the *COOLTOUR* project provide a concrete empirical ground for this claim: participants engaged in multimodal tasks such as creating memes, vlogs, blogs, interactive maps, and audio narratives, each of which required not the reproduction of predefined content but the articulation of situated, culturally inflected interpretations of heritage. Such activities

reveal a shift from education as transmission to education as design of meaning, foregrounding the learner not as a recipient but as a semiotic agent. In this context, the platform operates as a pedagogical ecology that supports forms of digital literacy spanning visual, affective, narrative, and meta-reflexive domains (Jewitt 2008; Cope and Kalantzis 2020b), positioning multimodality as a constitutive, not supplementary, dimension of learning. While the previous chapters have already demonstrated how the platform distributes modalities and encourages non-linear navigation, here we further emphasize the transformative character of its participatory architecture. This is particularly significant in comparison with platforms such as *Europeana* and *Google Arts & Culture*, which continue to operate under the logic of representational stability, the digital "showcase," and formal content curation.

Europeana is a digital archive that rests on the assumption of veridicality and authoritative control: cultural artifacts are catalogued, thematically organized, and visually homogenized, without conceptual openness to semantic reinterpretations. In this model, the user remains positioned as an archival searcher, without any fundamental affective or narrative role in the production of meaning. Such a model implies epistemological linearity and a hierarchy of knowledge sources, grounded in the logic of museological legitimacy. By contrast, *Google Arts & Culture*, though technologically more sophisticated, shares key similarities with *Europeana*. The user experience is determined by a highly curated visual layer, where artworks are presented in almost perfect digital reproductions, yet without the possibility of user intervention or reinterpretation. In this sense, *Google Arts & Culture* functions as a "visual spectacle" (Debord 1967)—one that fascinates but does not engage, that impresses but does not transform the user's relationship with content. In opposition, the *COOLTOUR* platform does not offer a ready-made narrative but invites the user to articulate one themselves. This practice aligns with the epistemology of critical constructivism, which requires not only reflection but also the transformation of knowledge through practice (Kincheloe 2005). The production of memes, vlogs, and hashtag metaphors (e.g., #RCPR) does not represent a mere "supplementary activity." However, it is essential to the educational value of the platform, since knowledge is not merely transmitted but produced within the discursive practices of users. Furthermore, whereas *Europeana* and *Google Arts & Culture* insist on a hierarchical display of cultural content, the *COOLTOUR* platform operates in accordance with horizontal models of cultural mapping, where users can prioritize local, everyday, or even marginal cultural elements, thereby disrupting the traditional hierarchy of representation. In this sense, the platform articulates what García Canclini (1995) refers to as hybrid cultural identities, in which institutional and informal knowledge intersect.

Regarding evaluation, the radical shift in roles also necessitates a change in metrics. While quantitative indicators, such as the number of views or the duration of user engagement, remain relevant, they cannot fully encompass the complexity of meaning production. What is required are qualitative indicators such as narrative coherence, depth of reflection, and the modal complexity of user-generated content. As Cope and Kalantzis (2020b) emphasize, evaluation must follow the principles of *learning by design*, where the process of meaning-making is just as important as the final product.

In this light, the proposed evaluative model for the *COOLTOUR* platform may include the following dimensions:

- Epistemological openness: Does the platform allow the user to construct different learning pathways?
- Modal innovation: Do users experiment with various expressive forms (video, meme, digital map)?
- Affective engagement: Does the content reflect the user's emotional involvement?
- Cultural resonance: Does the production contain local, linguistic, or symbolic references relevant to the user?
- Participatory depth: To what extent is the user integrated into the design, narrative, and interpretative processes?

Based on all the above, we may conclude that the *COOLTOUR* platform is no longer an "educational technology" in the classical sense, but rather a conceptual space in which meaning is formed through the dynamics of modalities, interpretation, and the cultural positioning of users. This transformation also demands a theoretical shift—from viewing digital media as tools for the transmission of knowledge to understanding platforms as ecosystems of meaning.

Critical redesign: Theoretical reflection and proposals for the platform improvement

In moving from analysis to redesign, it becomes necessary to view the *COOLTOUR* platform not as a stable technological product but as an evolving system shaped by the contingencies of user practice, interface logic, and cultural interpretation. Although the platform already embodies many principles of multimodal and participatory pedagogy, its current form reveals the incomplete, processual nature of digital heritage mediation. In the sense suggested by critical design theory, incompleteness is not a flaw but a diagnostic surface: a point where underlying epistemological assumptions become visible and open to transformation (DiSalvo 2009). The platform's present configuration, therefore, invites a set of questions fundamental to both media theory and educational design: *How is knowledge produced? Who participates in its formation? Which interpretive positions does the interface enable or foreclose?* This critical stance allows us to articulate redesign not as a matter of technical enhancement but as a rethinking of the pedagogical, and cultural frameworks through which the platform constructs meaning. Since most users, particularly those from Generation Z, access digital content through mobile devices (Prensky 2001: 1–6), the platform's design must be aligned with a mobile-first logic understood as a structuring condition of user engagement. As Norman (2005) and Kress (2010) point out, the affordances of the interface guide the interpretation of content, organize attention, and shape the user's affective engagement. The current design of the *COOLTOUR* platform still favours desktop logic and narrative linearity; in contrast, a shift toward a mobile-oriented, vertical, and visually accentuated design would enable more fluid and intuitive meaning flows.

Another central dimension concerns the motivational structures embedded in the interface. Social validation, the sense of progress, and the recognition of contributions are critical motivators for young users. Gamification—through the introduction of points, badges, or ranking systems—should not be seen merely as a means of "entertainment," but as a tool for affirming user agency (Gee 2007; Freire 1970). Currently, the platform encourages participation but does not provide an infrastructure for *recognition*. By implementing subtle mechanisms that reward contributions (e.g., content creation, visits to heritage sites, or interaction with others), *COOLTOUR* could develop a participatory economy of learning in which engagement is measured through contributions to the collective semiotic network. At the moment, the platform operates on the principle of universal content; therefore, all users receive a duplicate entry into the system. However, as personalization practices in services such as Spotify or TripAdvisor suggest, knowledge can be organized as *a situated resource*, dynamically adapting to the user's geographical location, prior interactions, or affinities. Such a model would transform the platform from a repository into *an adaptive pedagogical companion* that mediates and co-creates it in dialogue with the user (Lave and Wenger 1991).

Moreover, immersive technologies, now widely available, offer affective dimensions of learning. The possibilities afforded by augmented reality (AR) and virtual reality (VR) remain underutilized within the current platform framework. Experiential technologies enable a shift from the visualization of meaning to its embodied experience (Bolter and Grusin 2000; Dourish 2001). Interactive tours, AR filters for "trying on" historical artifacts (e.g., a Roman helmet), as well as virtual reconstructions of heritage sites, would enable a mode of learning that transcends textual and two-dimensional logics. In this way, learning shifts into *the domain of affect* and sensory engagement (Massumi 2002).

What should also be emphasized is that one of the most striking moments during the pilot implementations was the involvement

of local actors in content production. Such a practice suggests the possibility of expanding the platform to co-produce knowledge between users and institutions. Instead of a hierarchical model (institution → user), it is necessary to support a participatory model (user ↔ institution ↔ community), thereby activating the glocal dynamics of knowledge (Robertson 1995: 25–44) and affirming the principles of participatory design (Björgvinsson *et al.* 2012: 101–116). An illustrative example of such an approach can be seen in the practice of the City Museum of Zagreb[5], where the director, after conversations with young people from the local community, recognized the epistemological gap between her own generation (Generation X and the so-called baby boomers) and the media habits of Generation Z. Instead of attempting to "transmit" institutional knowledge to young people in a form unfamiliar to them, it was decided to entrust students and youth with the task of transforming existing museum content into formats that are aesthetically and communicatively accessible. Through a series of workshops, interactive tours, pub quizzes, and other cultural forms, young people were allowed to become interpreters and mediators of institutional material—not as passive recipients, but as cultural curators in a micro format.

Such a practice confirms the importance of structural flexibility and opens up the space for what Jenkins (2009) calls participatory culture, in which the boundaries between producers and users become porous. Furthermore, such models suggest that participation functions less as a technological option than as an epistemological and cultural stance—a means for institutions to adopt not only different forms of knowledge but also various modes of their shaping and distribution. In this sense, by following the aforementioned examples of good practice, the *COOLTOUR* platform could further develop mechanisms of local integration through an interface that actively encourages communities to reinterpret and present cultural narratives in forms aligned with their own aesthetic, affective, and linguistic codes. In doing so, the idea of culture from below is reaffirmed—a culture that is not centrally encoded but open to the mediating practices of local actors. In this process, the concept of digital shareability plays a decisive role, which should not be regarded as a neutral technical option but as a key mechanism of cultural visibility and participation in contemporary communication ecosystems.

If content is not designed in a way that allows it to circulate through the dominant visual-narrative forms of networks, such as TikTok and Instagram—through rhythmic optimization, visual attractiveness, and narrative condensation—it loses its potential to participate in the digital lives of communities actively. Shareability, thus, functions as a point of cultural recognition and the spread of knowledge in digital culture (Marwick 2013), rather than just a technical standard.

Naturally, the proposed changes should not be interpreted as cosmetic corrections or functional improvements, but as *epistemological interventions* into how knowledge is produced, distributed/transferred and perceived in the digital context. In line with critical pedagogy and theories of digital culture, every design choice is also an ideological decision—a choice concerning *who has the right to speak, who interprets, and who learns*. In this light, the redesign of the *COOLTOUR* platform is not merely a technical task, but a cultural process—one that must be guided by dialogue, theoretical reflection, and a profound understanding of the dynamics of knowledge in the networked age.

Despite its pedagogical potential, the *COOLTOUR* platform exhibits several limitations. The current version lacks systematic usability testing, server-side analytics, and performance metrics, which restricts the ability to assess user behaviour or long-term engagement. Mobile responsiveness and accessibility features remain only partially implemented, particularly with respect to contrast options, text scaling, and auditory support. Specific modules exhibit limited intermodal coherence, and technical constraints, such as loading speed, occasional instability, and the absence of personalization mechanisms, reduce the overall fluidity of the user experience. These limitations do not diminish the platform's conceptual value but indicate areas requiring further development.

[5] An example from practice documented in an informal institutional report during the study visit and stay in Zagreb (Croatia) within the framework of the *COOLTOUR* project, available to the authors.

CONCLUSION

This paper looks at another aspect of the *COOLTOUR* platform that came to light through research projects, workshops, and its ongoing presence in the digital space after the project ended. This aspect adds value to the platform's main goal, which is to serve as a digital link between cultural heritage professionals and Gen Z audiences. The analysis shows that the platform's importance is not just in how it works technically but also in how it grows through continuous human engagement and interaction. By focusing on multimodality, the study offers a unique way to think about digital tools in education and cultural heritage. Previous research has shown that interactive and participatory methods are key to modern heritage education. These methods help young users create meaningful experiences based on their own interpretations of academic knowledge and data. When these methods move into digital spaces, they promote awareness, responsibility, and long-lasting involvement with archaeological heritage. This, in turn, helps develop shared understandings of how to protect cultural heritage (cf. Plemić, Anđelković Grašar 2022, 153–164).

This paper presented a theoretical and analytical study of the *COOLTOUR* platform as a paradigmatic example and a model of multimodal, participatory, and critically grounded digital educational practice. Drawing upon the theories of social semiotics (Kress 2010), modal affordances (Bezemer and Kress 2016), critical pedagogy (Freire 1970; Cope and Kalantzis 2020b), and intermediality (Elleström 2010b), we have shown that the *COOLTOUR* platform functions as more than a technical infrastructure for the dissemination of cultural content. It operates as an interactive cultural environment in which meaning emerges in dialogue between users, modalities, and cultural context. Instead of the traditional educational logic of transmission and curation of knowledge, the *COOLTOUR* platform affirms a productive model of learning in which users—above all, young people—are positioned as agents of meaning. Their active participation in the design, narration, and interpretation of cultural content (through vlogs, memes, interactive guides, and digital maps) contributes to the development of new forms of digital literacy, while also reshaping the mechanisms of cultural memory. Meaning within this platform is not given but negotiated; it is not stable, but rather contextual and dynamic.

Through a comparative analysis with platforms such as *Europeana* and *Google Arts & Culture*, it has been further confirmed that *COOLTOUR* transcends the representational model of digital culture, in which the user occupies a passive role as a consumer. This distinction, however, should not be understood as a claim of technological superiority, but as an indication of divergent pedagogical and conceptual objectives. Instead, it promotes an agentive, non-linear, and semantically flexible framework in which education unfolds as a process of articulating identity and local meanings through contemporary digital languages. Such a horizontal framework opens the possibility for democratizing access to cultural heritage, while enabling the production of new meanings from users' perspectives, particularly those often marginalized within institutional narratives.

The theoretical matrix of the study has demonstrated that the modalities within the platform do not function in isolation but in integration, through what Bateman and Wildfeuer describe as intermodal coherence. Visual metaphors, iconographic symbols, and spatial narratives do not simply supplement the text, they substitute, challenge, and expand it—positioning the *COOLTOUR* platform as a site of semiotic performativity. At the same time, the use of hashtag-branded forms and the potential for digital personalization point toward a post-textual design of meaning, where education unfolds through the aesthetics, affect, and rhythm of the interface. However, the analysis has also revealed key areas for theoretically grounded improvement of the platform.

Despite the existing participatory mechanisms, specific segments still reflect a functionalist and curatorial logic of knowledge. The current desktop-oriented design, the absence of content personalization, and the

insufficiently developed tools for participatory creation and sharing of knowledge all point to the need for a critical redesign. A mobile-first approach, gamification as a recognition of agency, algorithmic personalization, and the integration of AR/VR technologies are not merely technical enhancements but carriers of new epistemological configurations. Particularly significant is the practice of the City Museum of Zagreb, where, through dialogue with young people, formats such as workshops, pub quizzes, and interactive tours were developed—an example that confirms how decentralized and glocal knowledge production can successfully transform institutional narratives. In this light, *COOLTOUR* could further affirm communities as active mediators of cultural heritage, not only through content but also through the very design of the interface, which should reflect their media habits, aesthetic affinities, and linguistic codes. When properly implemented, digital shareability becomes a channel of cultural visibility rather than a mere functionality.

Ultimately, the evaluation of such a system cannot be based solely on traditional metrics. The number of views, the length of time spent on a page, or the quantity of interactions do not reflect the pedagogical value of the platform. Instead, what matters are qualitative dimensions: the depth of interpretation, the modal complexity of expression, cultural relevance, and the emotional resonance with content. The *COOLTOUR* platform exemplifies a broader shift in digital education, in which learning becomes a process of creatively reconfiguring knowledge rather than reproducing predetermined content. In conclusion, the *COOLTOUR* platform should not be regarded as a finalized product, but as an open educational model, a prototype—a landscape of meaning in perpetual construction. It is not merely a technological resource, but a pedagogical field of struggle for interpretative rights—a space in which knowledge becomes the outcome of engagement and education, an act of cultural agency. Through a reverse engineering perspective, the *COOLTOUR* platform can be understood as a transferable analytical model. It reveals how meaning, participation, and pedagogy are configured within digital heritage environments. At a time when educational models are increasingly techno-bureaucratized and standardized, *COOLTOUR* demonstrates that participatory, modally complex, and semantically open systems are essential for the development of an educational format that is at once critical, culturally conscious, and aesthetically engaged. Elaborated results prove the need for such a model to be replicated, followed or supported on a broad European and generally international level, to which universal heritage values belong.

In this regard, *COOLTOUR* demonstrates that digital heritage platforms cannot be understood merely as technical solutions, but as cultural dispositifs in which meaning, memory, and participation are continually reconfigured. Its importance stems from its ability to present heritage as a living, negotiated practice, shaped through interaction, interpretation, and shared authorship, rather than through fixed functionalities alone. For this reason, *COOLTOUR* should be seen as an evolving cultural framework that invites institutions and communities to rethink how heritage is mediated, experienced, and imagined within contemporary digital ecologies. Such an orientation affirms that the future of cultural education depends less on technological provision and more on cultivating spaces where knowledge becomes a collaborative, critically engaged, and culturally situated act.

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REZIME

MULTIMODALNA ZNAČENJA I DIGITALNA KULTURA: KRITIČKA STUDIJA PLATFORME *COOLTOUR*

KLJUČNE REČI: MULTIMODALNOST, METODOLOGIJA, *COOLTOUR* PLATFORMA, KULTURNO NASLEĐE, KOMUNIKACIJA, DIGITALNA PEDAGOGIJA

Rad razmatra platformu *COOLTOUR* kao paradigmatski primer digitalne obrazovne prakse u polju kulturnog nasleđa, smeštajući je u širi teorijski okvir multimodalne komunikacije, kritičke pedagogije i intermedijalne analize. U vremenu postalfabetske pismenosti, gde generacije odrastaju u uslovima stalne izloženosti vizuelnim, auditivnim i interaktivnim sadržajima, tradicionalni transmisivni modeli učenja pokazuju se nedovoljno delotvornim. *COOLTOUR* platforma je u tom smislu predstavljena kao dinamički prostor u kojem obrazovanje o kulturnom nasleđu ne funkcioniše kroz linearni prenos znanja, već kroz proces dizajniranja značenja u kojem su korisnici istovremeno i recipijenti i producenti sadržaja.

Teorijski okvir rada obuhvata nekoliko ključnih koncepata. Pre svega, društvena semiotika i multimodalna analiza autora Gantera Kresa i Džefa Bezemera ukazuju na načine na koje različiti modaliteti – tekst, slika, prostor, zvuk – funkcionišu u međusobnoj interakciji. Model modalnih dimenzija Larsa Elstroma (materijalna, senzorijalna, prostorno-vremenska i semiotička) omogućava uvid u to kako značenje cirkuliše kroz transformacije između različitih medija, dok kritička pedagogija Paula Freirea, a potom i Bila Koupa i Meri Kalancis, obezbeđuje osnovu za promišljanje obrazovanja ne kao prenošenja sadržaja, već kao kolektivnog i participativnog procesa osmišljavanja značenja. Na tom tragu, *COOLTOUR* platforma se tumači kao otvoren sistem čija je najveća vrednost u mogućnosti da destabilizuje hijerarhije između ekspertskog i laičkog znanja, da uključi nove glasove i generacijske perspektive i da kulturno nasleđe pozicionira u dijalog sa savremenim društvenim praksama.

Analitički deo rada pokazuje kako platforma koristi multimodalne resurse za kreiranje specifičnog pedagoškog iskustva. Tekstualne naracije, fotografije, mape, kratki video-zapisi i mogućnosti za korisničku participaciju grade složen ekosistem značenja. Ipak, primećuju se i ograničenja: nedovoljna razvijenost auditivnih i haptičkih slojeva, povremena fragmentacija između teksta i slike, kao i potreba za dubljom integracijom modaliteta u smeru potpune intermodalne sinergije. Uprkos tome, snaga platforme leži u njenom potencijalu da generiše „redizajn značenja" – trenutke kada korisnici aktivno rekonstruišu kulturne sadržaje kroz sopstvenu kreativnost i kritičku interpretaciju.

Empirijski deo rada dodatno osnažuje teorijske uvide kroz analizu iskustava učesnika *COOLTOUR* obrazovnih mobilnosti, naročito tokom *C1 mobilnosti* realizovane na arheološkom lokalitetu Viminacijum. Kvantitativni i kvalitativni evaluacioni podaci ukazuju da učenje u ovom kontekstu ne nastaje kroz usvajanje unapred definisanih informacija, već kroz situirano, telesno i kolaborativno angažovanje učesnika. Rezultati pokazuju visok stepen razvoja komunikativnih, digitalnih i interkulturnih kompetencija, kao i jačanje osećaja evropske pripadnosti, što potvrđuje da multimodalne i participativne strategije imaju snažan pedagoški efekat upravo u domenu značenjskog učenja. Kvalitativni iskazi učesnika dodatno ukazuju na pomeranje obrazovnog okvira: od linearne potrošnje sadržaja ka distribuiranom procesu zajedničkog osmišljavanja značenja.

Ovi nalazi omogućavaju da se *COOLTOUR* platforma sagleda ne samo kao tehničko rešenje ili obrazovni alat, već kao epistemološki okvir koji aktivira korisničku agensnost i omogućava proizvodnju kulturnog značenja kroz narativne, vizuelne i prostorne prakse. U tom smislu, platforma funkcioniše kao eksperimentalni model digitalne pedagogije u kojem se znanje pojavljuje

kao performativni proces – kao nešto što se proizvodi u interakciji između dizajna interfejsa, modalnih resursa i kulturnog konteksta korisnika.

Na širem teorijskom planu, rad doprinosi razvoju studija digitalnog kulturnog nasleđa ukazujući da su pitanja multimodalnosti, participacije i afekta ključna za razumevanje savremenih obrazovnih platformi. *COOLTOUR* se tako ne pozicionira kao alternativna verzija postojećih digitalnih repozitorijuma, već kao drugačiji tip kulturnog dispozitiva, koji omogućava da se nasleđe sagleda kao otvoren, kroz pregovore vođen i društveno situiran proces značenja.

U poređenju sa etabliranim digitalnim platformama poput *Europeane* ili *Google Arts & Culture*, *COOLTOUR* se izdvaja naglaskom na participaciju i lokalnu angažovanost. Za razliku od ovih tehnološki naprednijih i infrastrukturno kompleksnijih sistema, *COOLTOUR* ne teži tehničkoj superiornosti, već razvoju participativnih, lokalno utemeljenih i pedagoški refleksivnih modela digitalne edukacije. Dok velike međunarodne baze teže stabilnosti i kuratorskom autoritetu, *COOLTOUR* se oslanja na horizontalnu logiku zajedničkog stvaranja sadržaja i time ostvaruje veći inkluzivni potencijal. Ovaj pristup se može tumačiti i u svetlu teorija hibridnih kulturnih identiteta, među kojima je i ona Nestora Garsije Kanklinija, gde digitalni medijatori omogućavaju susret i preplitanje različitih kulturnih praksi i narativa.

Kritička refleksija ukazuje da *COOLTOUR* ne treba posmatrati kao dovršen proizvod, već kao procesualni kulturni artefakt, otvoren za stalna unapređenja i transformacije. Preporučuju se inovacije poput *mobile-first* dizajna, proširene i virtuelne stvarnosti, gejmifikacije, ali i intenzivnije lokalne koprodukcije. Na taj način, platforma može još snažnije da funkcioniše kao semiotički ekosistem i pedagoško polje borbe za interpretativna prava, u kojem znanje ne cirkuliše jednostavno odozgo nadole, već emergira kroz dijalog između modaliteta, korisničke agensnosti i kulturnog konteksta.

Dodatno, rad pozicionira *COOLTOUR* u teorijski horizont intermedijalnosti i transmedijalnosti, ističući da digitalne prakse kulturnog nasleđa više ne funkcionišu kroz stabilne oblike reprezentacije, već kroz procese prenošenja i transformacije narativa između različitih medijskih formi. U tom smislu, platforma omogućava da se kulturno pamćenje ne razume kao arhivski resurs, već kao dinamičan *storyworld*, koji se neprestano rekonfiguriše kroz digitalne slike, mape, zvuk i interakciju. Ovakav pristup povezuje se sa savremenim teorijama digitalne kulture, koje ukazuju da platforme ne služe samo čuvanju prošlosti već oblikuju režime njene vidljivosti, interpretacije i deljenja. U širem kontekstu, rad doprinosi razumevanju digitalnog nasleđa kao polja u kojem se epistemologija, estetika i tehnologija međusobno prepliću. Time *COOLTOUR* ne predstavlja samo primer uspešne prakse, već i teorijski model za promišljanje kulturnog pamćenja u doba platformi, gde se granice između medija, zajednice i znanja neprestano pomeraju i redefinišu. Dakle, platforma funkcioniše kao primer tzv. performativne arhive, odnosno prostora u kojem se znanje ne samo prezentuje već proizvodi kroz participaciju korisnika i medijaciju tehnologije i afektivnu dimenziju digitalne interakcije. Zaključno, rad ukazuje da ovakav model digitalne edukacije predstavlja mogući prototip budućih kulturnih i obrazovnih platformi, gde se intermedijalnost, participacija i afekt povezuju u nove oblike kulturne pismenosti i zajedničkog učenja.

COOLTOUR, dakle, pokazuje kako digitalne platforme mogu postati generatori novih oblika obrazovanja o kulturnom nasleđu, utemeljenih na multimodalnoj ekspresiji, intermedijalnim transformacijama i kritičkoj participaciji. Time se otvara prostor da se nasleđe ne razume kao prošlost zatvorena u arhivima, već kao živ proces značenja u kojem savremeni korisnici postaju aktivni akteri kulturne produkcije.

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Use of tools based on large language models and generative AI: ChatGPT (translation); Grammarly (initial proofreading).

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TROJANOV GRAD, SERBIA - METHODOLOGICAL APPROACH AND ANALYSIS OF DATA OBTAINED THROUGH A SERIES OF LIDAR SURVEYS

ABSTRACT

Trojanov Grad is an archaeological hillfort site situated on the eastern slopes of Mount Cer in Serbia. Its strategic position commands a wide view over Pocerina, the eastern parts of Jadar, and the south-eastern regions of Mačva.

Previous excavations have identified cultural layers from the transitional Bronze Age to the Iron Age and the Roman period. However, dense forest vegetation has long limited a comprehensive understanding of the site's defensive morphology and internal organization. Recent technological advancements, particularly in unmanned aerial systems (UAS) equipped with LiDAR (Light Detection and Ranging) sensors, now enable detailed mapping of terrain even under forest cover. In this study, multiple overlapping LiDAR surveys were processed into high-resolution Digital Elevation Models (DEMs) using enhanced ground-point filtering techniques to improve the visibility of subtle archaeological features. The results demonstrate that refined visualizations derived from the integrated datasets provide a significantly clearer and more accurate representation of the hillfort, revealing structural elements previously undetectable in traditional field surveys. This paper outlines the methodological workflow, from data acquisition to interpretation, and highlights the contribution of LiDAR-based remote sensing to the renewed understanding of Trojanov Grad and its role within the broader regional landscape.

KEYWORDS: TROJANOV GRAD, MOUNT CER, LATE BRONZE AGE, EARLY IRON AGE, LATE ANTIQUITY, METHODOLOGY, UAV, REMOTE SENSING, LIDAR SYSTEM, DJI.

INTRODUCTION

The application of drones in archaeology is multifaceted, owing to their capacity to integrate a variety of remote sensing instruments and measurement sensors. Moreover, the use of UAVs and remote sensing technologies has made it possible to capture and subsequently conduct detailed analyses of extensive areas and features—such as archaeological sites and cultural monuments—that for many years could not be adequately recorded, measured, described, or analysed with the necessary precision (Живановић и др. 2024: 60).

Remote sensing is a scientific research method that has, for many years, been one of the predominant techniques for collecting spatial data (Милановић и др. 2020: 12). Numerous

authors have offered definitions of the term; here, we provide one to eliminate any potential professional ambiguity: remote sensing is a method of acquiring information through systems that are not in direct physical contact with the phenomenon or object under investigation (Pejić 2004: 87). In the introductory section, we will also outline all the elements involved in the remote sensing process, while the subsequent chapters will examine each component and the methodological approach in greater detail. The elements that constitute the remote sensing process include: the subject of research (object), electromagnetic energy, sensor, platform, image, analysis of remote images, interpretation, and usable information (i.e., processed remote sensing data) (Академия наук СССР 1978; Милановић и др. 2020: 14).

Trojanov Grad, a hillfort-type archaeological site situated on the eastern slopes of Mount Cer in Serbia, was frequently described by early chroniclers and travel writers, who consistently referred to it as either a Roman or a Serbian city (Живановић и др. 2025: 124) (**Figure 1**). The site occupies a prominent plateau at an elevation of above 600 metres, measuring 250 by 80 metres.

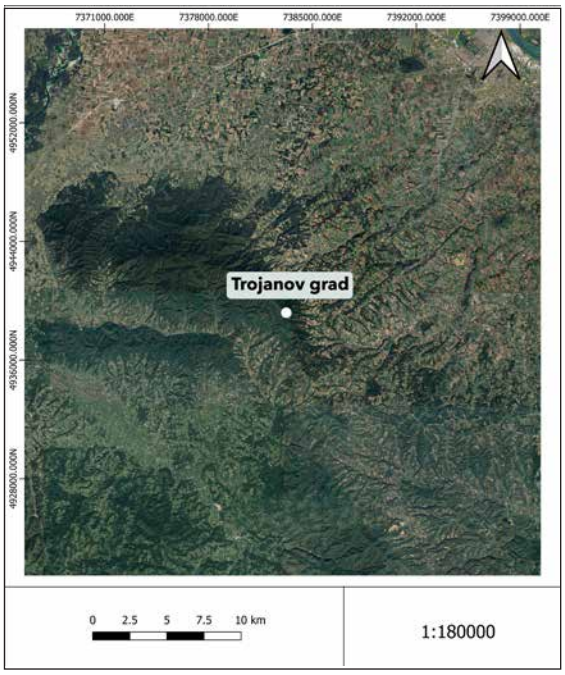

Figure 1. Satellite image of Mount Cer, Pocerina, east Jadar and southeast Mačva (Photo from Google Earth Pro, October 2024, modified by the authors on April 10th, 2025.).

This expansive plateau is accessible from the east and west, while its northern and southern flanks are naturally fortified by steep slopes (Bulatović i dr. 2017: 39; Булатовић и др. 2017: 246). Recent field investigations suggest that the eastern side was additionally fortified by substantial defensive structures, including walls and a ditch (Bulatović i dr. 2017: 40). The site occupies a highly strategic position, which accounts for its habitation since prehistoric times, specifically during the transitional period between the Late Bronze and Early Iron Age.

For a long time—since the earliest written travelogues—it was assumed that two distinct chronological layers were present at the site: an ancient layer, interpreted as a fortification dating to the late 3rd or early 4th century CE, forming part of a broader defensive system spanning the Cer mountain range and serving as a strategic outpost for the protection of mining operations and lowland settlements from barbarian incursions (Арсић 2011: 62–82), and a medieval layer, presumed to date to the Late Middle Ages, although this assumption has not been confirmed through excavation. However, recent archaeological investigations conducted in 2013 and 2014 have clearly identified a cultural layer corresponding to the transitional period between the Late Bronze and Early Iron Age.

Despite the abundance of written sources and the archaeological investigations conducted to date, Trojanov Grad has never been fully observable, due to the dense forest vegetation covering the slopes of Mount Cer. However, the development of computer software and unmanned aerial vehicles (UAVs) has greatly facilitated the simplified and increasingly widespread application of remote sensing methods in the processing, analysis, and documentation of both movable and immovable archaeological materials. With their rapid technological advancement, UAVs have become highly effective and nearly indispensable tools in archaeological research, frequently resulting in savings of time and resources while enabling high-precision spatial data collection (Живановић и др. 2025: 125).

It was precisely through the application of one remote sensing method—the LiDAR (Light Detection and Ranging) system—that Trojanov Grad could finally be observed in its entirety. This

method involves laser scanning of the Earth's surface using an airborne imaging system. The use of such a system enables the collection of extensive data, providing a wealth of information about recorded objects, phenomena, and surface processes, with a high density of three-dimensional coordinate points generated by laser pulses (Милановић и др. 2020: 74). The quality of LiDAR scanning is influenced by several factors, including the wavelength of the laser, the frequency of the laser pulses, the diameter of the pulse, and the power of the laser. LiDAR systems measure the time it takes for each laser pulse to travel between the sensor and the observed object on the Earth's surface. This allows for the acquisition of both positional data of the system and reflectance data from the scanned surface (Милановић и др. 2020: 74).

Through systematic methodological work, we concluded that by applying different parameter settings across a series of flights, certain ground features of the site of Trojanov Grad became visible in one image that were not discernible in another. Additionally, other parameter configurations yielded images with cleaner resolution. By integrating multiple images generated under varying conditions, we were able to produce a significantly clearer and more comprehensive representation of the site. The results of this analysis, along with the detailed methodological approach, will be presented in the sections that follow[1].

LIDAR APPLICATIONS IN ARCHAEOLOGY

Airborne LiDAR (Light Detection and Ranging) has revolutionized archaeological prospection by enabling the generation of high-resolution topographic data, even beneath dense vegetation. LiDAR systems emit laser pulses from an aircraft or drone and measure the return time of each pulse to construct three-dimensional point clouds of the terrain. These point clouds are then processed to produce digital elevation models (DEMs) and various terrain derivatives—such as slope, local relief, and sky-view factor—that can reveal subtle anthropogenic features, including roads, ditches, and building foundations, which would otherwise remain undetectable at ground level (Caspari 2023). In densely forested or scrub-covered landscapes—common throughout the Balkan region—LiDAR can penetrate the vegetation canopy to capture the underlying ground surface, revealing entire settlement landscapes and land-division patterns that have long eluded traditional archaeological survey methods (Caspari 2023). For example, extensive Roman-era centuriations and medieval field systems have been mapped beneath forest canopies across Europe thanks to LiDAR technology. In short, modern LiDAR represents a "toolbox revolution" in archaeology, facilitating multiscale landscape analysis with unprecedented precision.

UAV LiDAR data acquisition, processing and interpretation

Today, most archaeological LiDAR data is collected using drones (UAVs) equipped with lightweight laser scanners. Standard configurations typically employ rotary-wing drones—such as the DJI Matrice series—fitted with integrated LiDAR sensors and GNSS/IMU systems. For instance, the DJI Zenmuse L1 sensor, which utilizes a Livox Avia laser with a 240° field of view, mounted on a Matrice 300 RTK platform, is capable of recording approximately 450,000 points per second. These systems georeference each laser pulse using real-time kinematic (RTK) GPS and an inertial measurement unit (IMU), achieving absolute positional accuracy at the centimetre scale. Drone flights are planned as a grid of straight, parallel flight paths with side and forward overlaps, ensuring dense point cloud coverage across the entire surveyed terrain. Low-altitude flights, typically 30–50 metres above ground level, produce exceptionally high point densities—often in the thousands of pulses per square meter—which are critical for detecting subtle archaeological features in the micro-topography. DJI's newer Zenmuse L2 sensor, which incorporates a Livox Micro laser, introduces

[1] The results of this work were partially presented during the *48th Assembly and Annual Meeting of the Serbian Archaeological Society.* The abstract of this paper was partially published in Serbian, as an abstract for the publication resulting from the assembly and the meeting (Живановић и др. 2025: 124–125)

a multi-return capability (up to five echoes per pulse) and a higher pulse rate, significantly enhancing canopy penetration and ground-return density. In practice, LiDAR missions routinely cover several square kilometres per day, rapidly producing high-resolution surface models in wooded or remote areas where traditional ground-based survey methods are impractical.

Following data acquisition, raw LiDAR data is processed through a series of stages. First, the point cloud is georeferenced and co-registered using onboard GNSS/IMU logs, which are often post-processed with base-station corrections to enhance accuracy. Subsequently, classification algorithms are applied to distinguish ground from non-ground returns. Standard workflows—such as those implemented in LAStools, the Cloth Simulation Filter (CSF), or the QGIS Processing Toolbox—filter out vegetation and noise, isolating the bare-earth point set. From these classified ground points, a Digital Terrain Model (DTM), or bare-earth Digital Elevation Model (DEM), is then interpolated.

Georeferencing and DTM generation. The aligned point cloud is rasterized into a high-resolution DTM, with grid cell sizes ranging from 0.05 to 0.25 metres. This model may then be smoothed to eliminate isolated outliers. The overall accuracy depends on sensor quality; for example, a calibration test using a DJI Matrice 300 RTK paired with the Zenmuse L1 sensor achieved approximately 3.5 cm positional accuracy after adjustment—surpassing the manufacturer's stated specification of 10 cm. The newer DJI Matrice 350 RTK, combined with the Zenmuse L2 LiDAR sensor, exhibits notable improvements in positional accuracy compared to its predecessor. Under optimal conditions—with the RTK system in FIX status, IMU calibration enabled, a flight altitude of 150 metres, and a speed of 15 m/s—a horizontal accuracy of 5 cm and a vertical accuracy of 4 cm were achieved. Flight planning was conducted using DJI Pilot 2, with post-processing performed in DJI Terra. Field tests further indicate that the Zenmuse L2 provides improved accuracy over the L1; for example, at a flight altitude of 50 metres, the L2 recorded an absolute vertical error of 44 mm, compared to 51 mm for the L1 (Willoughby 2023).

Derivative surfaces. Archaeologists subsequently generate topographic derivatives to enhance the visibility of subtle anthropogenic features. Commonly produced derivatives include hillshade and slope maps, the Local Relief Model (which subtracts a smoothed DEM to emphasize micro-topographic variations), Sky-View Factor (which depicts landscape openness, accentuating depressions and embankments), and the Topographic Position Index. These visualizations are particularly effective in revealing linear ditches, embankments, and building platforms. For instance, by employing sky-view factor and slope rasters, researchers successfully delineated a Bronze Age hillfort in Poland, achieving 93% accuracy in the automated classification of its rampart and ditch (Łabuz *et al.* 2023: 83). Visual integration of multiple layers (e.g., RGB shade, LRM, and sky-view) in GIS helps archaeologists identify anomalous shapes.

Feature identification. Potential archaeological features—such as ditches, walls, or pits—manifest as geometric anomalies on the DTM and its derivative surfaces. These anomalies are typically interpreted manually by experienced analysts, often with the support of semi-automated tools. For example, in a Slovak study, researchers identified both previously known Bronze- and Iron-Age house platforms and newly discovered medieval farmstead remains by analysing colour-blended slope and sky-view factor rasters. Suspected features are subsequently verified through targeted ground inspection or geophysical survey. Integrating LiDAR with complementary remote-sensing techniques—such as ground-penetrating radar (GPR) or magnetometry—enhances interpretive confidence. In one Croatian project, for instance, airborne LiDAR was combined with 3D GPR to successfully reconstruct a protohistoric tumulus and hillfort in Istria (Bernardini *et al.* 2021). While UAV-LiDAR excels at rapidly mapping large-scale surface micro-relief, even beneath vegetation, its effectiveness is constrained by point density, canopy complexity, and surface materials, and it cannot fully process deeply buried structures (Vinci *et al.* 2024). Therefore, LiDAR is most powerful when integrated with subsurface geophysical methods (e.g., ground-penetrating radar), which can resolve buried stratigraphy and

features that LiDAR cannot, albeit over smaller, more time-consuming survey extents.

Archaeological applications (prehistoric to modern)

LiDAR deployed on drones has revolutionized archaeological prospection by providing high-resolution terrain models even under dense vegetation (Bernardini 2023). This technology "virtually" strips away forest cover, revealing subtle earthworks that are otherwise invisible on the ground. As a result, archaeologists can detect and document buried or overgrown features from all periods – prehistoric enclosures, ancient roads, abandoned medieval villages, even modern battlefield trenches – all within the same LiDAR-generated landscape model.

In prehistoric archaeology, drone-mounted LiDAR has uncovered extensive Bronze and Iron Age earthworks that were previously unrecognized. A notable example comes from the Friuli Plain in north-eastern Italy, where a recent high-resolution LiDAR survey mapped numerous Late Bronze Age monumental earthworks (Vinzi and Vanzani 2025). By comparing LiDAR-derived digital elevation models (DEMs) to old topographic surveys, researchers obtained complete profiles of prehistoric burial mounds and fortified settlements. Precise volumetric measurements of each mound and rampart were made, allowing estimates of the labour and time required for their construction. These analyses provide insight into sophisticated Bronze Age construction techniques and reveal a clear hierarchy of settlements, with Udine emerging as a top-tier centre surrounded by smaller forts (Vinzi and Vanzani 2025). LiDAR proves effective across diverse terrains. In the open alluvial plains of Friuli, it captured subtle relief differences corresponding to levelled earthworks; in rugged or forested landscapes, it performs just as well. Karstic and woodland environments—often challenging for traditional survey—have yielded significant finds through LiDAR. For example, in the karst hills of Istria (Croatia), archaeologists combined LiDAR data with targeted geophysical scans to identify a Bronze/Iron Age burial mound and the earthworks of a small hilltop fortification hidden by scrub and limestone outcrops. Even heavily wooded hilltops can hide prehistoric forts that LiDAR brings to light. In one Polish study, an obscured Lusatian culture hillfort was detected on a forested hill using LiDAR-derived visualizations. The fort's ditch-and-bank outline, imperceptible on the ground, became clear in the LiDAR-based models. Impressively, the researchers then applied an automatic feature-detection algorithm to the LiDAR data – the software isolated the circular rampart and ditch of the hillfort with about 93% accuracy, closely matching manual mapping (Łabuz *et al*. 2023).

The LiDAR methodology has proven equally transformative for landscapes of the Classical Antiquity and medieval periods. In north-eastern Italy's Trieste Karst region, for example, airborne LiDAR uncovered an extensive Roman rural landscape long hidden in the wooded limestone plateau (Bernardini 2023). By digitally removing the thick vegetation, a lost network of ancient Roman roads and settlements was revealed. The DEM clearly showed multiple roads crisscrossing the karst plateau, totalling over 10 km in length, along with rectilinear grids of field boundaries (centuriation lines) and the foundations of sizable Roman buildings (Bernardini 2023). Many of these features were previously unknown. Tellingly, the newly mapped road alignments coincided with spots where Roman hobnails (shoe nails from Roman sandals) and coins had been found on the surface, firmly dating the roads to the Roman period. One large structure revealed by LiDAR — a rectangular complex adjacent to a road junction — is hypothesized as the long-lost "Avesica" road station, a stopping point mentioned in ancient itineraries (Bernardini 2023). LiDAR is equally adept at revealing medieval and post-medieval features that have faded from view. Once-familiar elements of the medieval cultural landscape – field terraces, hollow ways, village earthworks, and castle mounds – often survive as shallow relief differences that LiDAR can detect. For instance, LiDAR surveys in parts of Central Europe have pinpointed the grid-like banks and lynchets of medieval terraced agriculture, as well as the building platforms of deserted villages concealed in secondary forests. In one case from Slovakia, LiDAR imaging identified the plan of a deserted medieval farmstead (abandoned in the 16th century) whose earthwork building foundations

and enclosure ditches were completely overgrown and invisible to observers on the ground. Similarly, LiDAR-aided explorations in Switzerland's Berner Oberland have led to the discovery of several previously unknown medieval hilltop castles and fortifications in wooded areas, their ramparts discernible only through laser scanning.

One remarkable advantage of LiDAR is that it captures features from all time periods simultaneously, creating a layered "palimpsest" of landscape history. In the Trieste Karst dataset mentioned above, the same LiDAR model that revealed Roman roads also sharply delineated the trenches and artillery positions from World War I, which scarred the plateau during 20th-century battles (Bernardini 2023). In the forests of that region, one can see zig-zag trench lines and bomb craters from the early 1900s superimposed near much older archaeological features. LiDAR surveys in other areas have likewise recorded modern relics: for example, abandoned WWII bunkers, shell craters, and military training earthworks are commonly identified on LiDAR-derived maps, often in conjunction with older objects. The ability to detect multi-period features is extremely valuable for cultural heritage management. Researchers can disentangle overlapping features by using historical records, artifact finds, or stratigraphic clues, but LiDAR provides the comprehensive base map. Essentially, a single UAV LiDAR scan can produce a seamless visualization of the landscape's relief, within which traces of different eras can be distinguished by shape and context.

UAV-based LiDAR has rapidly become more accessible and powerful, suggesting that even more archaeological discoveries are on the horizon. Lightweight drone-mounted LiDAR sensors (such as DJI's Zenmuse L1 or L2 series) now allow high-density scanning at relatively low cost, covering large areas in fine detail. These systems can be flown over challenging terrain and forests that ground teams would struggle to survey. The resulting point clouds and DEMs are processed with advanced software pipelines to produce detailed visualizations (slope maps, local relief models, 3D renderings, etc.) that accentuate archaeological micro-relief. Increasingly, archaeologists are integrating LiDAR with other remote sensing and analytic techniques. For example, machine-learning algorithms are being trained to recognize the tell-tale shapes of archaeological features in LiDAR data. As noted above, one project achieved automated detection of a prehistoric hillfort with around 93% accuracy, by feeding LiDAR-derived raster images into a segmentation model (Łabuz *et al*. 2023). Comprehensive surveys of entire cultural landscapes—from prehistory through to the modern era—are now feasible, even beneath a forest canopy (Caspari 2023; Bernardini 2023). European scholars are actively building upon these developments: new national LiDAR initiatives, such as Switzerland's ongoing swisstopo campaign, are increasingly being leveraged for archaeological research (Caspari 2023). As more regions adopt UAV-based LiDAR systems and as open-access DEM databases expand, a substantial wave of new discoveries can be anticipated.

Applications in Serbian archaeology

Neighbouring countries, as discussed in previous chapters, provide several well-documented examples of the successful adoption of LiDAR technology in archaeological research. Of particular relevance, given the comparable environmental conditions and period context, are recent surveys of Roman fortifications and structures in Romania (Marcu 2024: 443–446). In the following section, we outline the most significant and influential studies conducted within the local research landscape. In Serbia, the first significant application of LiDAR in archaeology was facilitated by the ArchaeoLandscapes Europe project (CULTURE 2007–2013), coordinated by the Roman-Germanic Commission (Иванишевић и Бугарски 2012; Иванишевић и Бугарски 2013). Through this initiative, the Archaeological Institute in Belgrade conducted LiDAR surveys in two key areas: the confluence of the Great Morava and Danube rivers, and the site of Justiniana Prima in southern Serbia. The former includes the ancient city of Margum and the medieval settlement of Morava (Иванишевић и Бугарски 2012: 239), while the latter represents a unique Byzantine imperial foundation.

The LiDAR surveys yielded critical new data. At Margum-Morava, the scans confirmed the layout and extent of the settlements, revealed

what is likely a medieval defensive canal, and enabled the creation of a detailed situational plan. The analysis also led to the re-dating of nearby fortifications such as Kulič, suggesting that it was constructed after the flooding of medieval Morava—contrary to earlier views that associated it with the Roman period. Moreover, previously undocumented features, including Ottoman-period outposts mentioned by early modern travellers, were identified. At Justiniana Prima, LiDAR revealed an additional city wall enclosing a further 4.5 hectares, expanding the known walled area from 7.3 to 11.8 hectares. The scans also uncovered the foundations of two previously unknown fortifications—Sveti Ilija and Svinjaričko Gradište—and extended the known length of the town's aqueduct from 200 metres to approximately 2 kilometres. Subsequent fieldwork confirmed these findings and further traced the aqueduct's path toward its source on Mount Radan (Иванишевић и Бугарски 2013: 83–84).

Another notable example of LiDAR's application in Serbia is the archaeological investigation of Bassianae, a Roman municipium located in the present-day region of Srem. In 2021, LiDAR surveys were conducted over the northern part of the site, covering approximately 75 hectares of agricultural land (Filzwieser *et al*. 2021). The primary objective was to detect surface and subsurface archaeological features using high-resolution topographic data, particularly since the site is largely covered by modern cultivation and lacks visible above-ground architecture. The scans revealed numerous previously undocumented geomorphological features. Among the most significant were traces of the Roman urban grid, including road networks, building foundations, and other infrastructural elements.

The processed LiDAR data yielded a Digital Terrain Model (DTM) with a spatial resolution of 10 cm, allowing for the detailed visualization of subtle surface anomalies and anthropogenic formations. Notably, the data enabled a more precise definition of the northern city limits, clarifying the layout of fortifications and urban expansion beyond previously assumed boundaries. Additionally, several linear depressions and ditches identified in the dataset likely represent ancient water-management systems or roads. These insights have significantly advanced the understanding of the site's spatial organization and its interaction with the surrounding landscape.

TROJANOV GRAD

Spatial and archaeological contexts of the site

Owing to its commanding position, the site of Trojanov Grad affords visual control over a vast area of Podrinje and the surrounding regions—namely Pocerina, eastern Jadar, and south-western Mačva (Булатовић и др. 2017). The geographic characteristics of Podrinje—particularly Mačva, which serves as a natural corridor linking the expansive Hungarian Plain to the north with the hilly and mountainous regions of the Balkans to the south (Vuković and Tripković 2024: 153–154)—make it one of the most strategically important corridors, highly sought after throughout history. In addition, Podrinje encompasses fertile plains centred around Mount Cer—an ancient extinct volcano—whose slopes extend into nearly every part of the region. Notably, Mount Cer is rich in mineral resources, particularly copper and tin (as evidenced by the Srebrne Rupe copper mine), which are also found along its slopes and in the smaller mountains of the Dinaric system, especially in the regions of Rađevina and Azbukovica (Филиповић 2024: 17–18). This underscores the strategic importance of the site during the late 3rd or early 4th century CE.

From Trojanov Grad, a significant portion of Mačva—an expansive plain covering approximately 900 square kilometres—could be effectively monitored (Стојић и Церовић 2011: 15), making it the most fertile area in Serbia after the Pannonian Plain and Stig. Adjacent to Mačva lies Pocerina, a hilly-mountainous region situated between Mačva and Posavo-Tamnava, notable for its abundance of natural and mineral resources. This microregion forms the northern foothills of Mount Cer, a prominent mountain located on the edge of the Pannonian Basin, with a peak elevation of 687 metres (Стојић и Церовић 2011: 15). Jadar is a region named after the Jadar river, which divides Podrinje into northern and southern sections. As a right-bank tributary of the Drina river, and with its numerous smaller

tributaries, the Jadar represents a significant hydrological resource for the region (Трбуховић и Васиљевић 1983: 10), with extremely fertile land along its valley. Within the Jadar region, three subregions can be distinguished: the Cer Massif with Iverak in the north, the Jadar basin featuring the alluvial plain of the Drina in the centre, and the Gučevo mountain range in the south, which reaches an elevation of 779 metres (Булатовић и др. 2017: 20).

The remains of this fortified settlement are located on Mount Cer, at the terminus of a mountain ridge, on the southernmost spur of the massif. The fortification occupies a relatively level plateau with a gentle southern incline, bordered on all sides—north, west, east, and south—by steep slopes. Based on previously documented remains, an ancient road likely followed a route roughly corresponding to the present-day path. Today, the fortification area is entirely overgrown with a sparse oak forest and low shrubs. The only structure still visible above ground is the remnant of a polygonal tower situated at the far north-western corner of the fortress. Sections of wall occasionally emerge from the ground but are largely buried beneath rubble and soil. The topography suggests that the walls are well preserved in places, reaching heights of over 1.5 metres.

The entrance to the fortification was most likely located on the south-eastern side, where the terrain reveals the outline of a gateway approximately four metres wide. The settlement itself is elongated and elliptical in shape, adapted to the natural contours of the ridge. The maximum length of the fortification is 180 metres, with a maximum width of around 60 metres. The late antique period introduced a number of innovations in military architecture, among which the construction of projecting towers—square, circular, or polygonal in plan and extending beyond the main curtain wall—was particularly significant (Rankov Kondić 2013: 49–50). In the event of an attack, these towers offered defenders unobstructed access and a clear line of sight along the ramparts, significantly enhancing control over the fortification's most vulnerable points, particularly in the areas near the gates. The construction of new forts, or the reconstruction of older ones with this type of defensive enhancement, can be observed across nearly the entire territory of present-day Serbia, from the strategic defence of the Danubian frontier (Pop-Lazić and Rummel 2020: 231) to Galerius's opulent imperial palace at Gamzigrad (Čanak-Medić and Stojković-Pavelka 2011: 57–58). This architectural evolution is evident from the time of the Tetrarchy through to the rule of Theodosius I (Petrović and Vasić 1996: 21–22).

Prior scholarly interest in the site prompted small-scale archaeological test excavations carried out in 2013 and 2014. As part of these investigations, four test trenches were opened, within which movable archaeological material dating to Antiquity and prehistory was documented. Approximately 5–6 metres northwest of the polygonal tower, in trench 2, researchers identified a structure made of dry-laid stone (without mortar), on and beneath which ceramic material was found, dating to the transitional period from the Late Bronze to Early Iron Age (Bosut culture). This structure—a dry-stone wall—was provisionally interpreted, based on the limited excavation, as part of a prehistoric fortification wall. On its exterior side lie a sharp drop and a shallow artificial ditch, which clearly served a defensive function for the western approach to the fort. The absence of wall remains in other trenches prevents a clear reconstruction of its full extent along the edge of the plateau, likely due to later construction activities dating to the late 3rd and early 4th centuries. No traces from later periods have been discovered thus far, suggesting that the fortification was not occupied during the Early Byzantine or medieval periods. The most recent finds from the site are artifacts from World War I (Булатовић и др. 2017: 41).

Several similar hillfort-type settlements are located in the immediate vicinity of Trojanov Grad. These include Gradac in Cikote, the hillforts of Oštenjak in Likodra and Vidin's Grad on the western slopes of Mount Cer, as well as Gradac in Banja Koviljača, situated on the right bank of the Drina river (Булатовић и др. 2017). Several similar fortifications have also been recorded in the Kolubara river basin (Арсић и др. 2013: 125–131).

The overall distribution of these fortifications within the aforementioned zone suggests that they formed part of a complex settlement and defence system dating to the Early Iron Age. They

likely functioned as both military and economic strongholds, closely linked to the exploitation of mineral resources in western Serbia. This primarily refers to copper and tin ores but also includes deposits of silver and iron (Bankof *et al.* 2013; Булатовић и др. 2017). Given all the aforementioned characteristics, the fortification of Trojanov Grad stands out as a unique site, both in terms of its location and the nature and preservation of its architectural remains. It is one of the rare sites in Serbia where traces of exceptionally high-quality stone architecture from the Early Iron Age have been preserved. Its significance clearly extends beyond the local context.

Recent investigations at Trojanov Grad have demonstrated that it is a highly significant fortified settlement with a complex, multi-period history. Excavations have confirmed an Early Iron Age occupation layer alongside a later Late Roman hilltop fortification. These findings support earlier historical associations of the site as a "Roman" stronghold, while simultaneously refuting any claims of medieval reoccupation. Stratigraphic analysis identified a Bosut-culture stone wall and ditch (10th–9th century BCE) on the western scarp, accompanied by a massive rubble rampart. No Early Byzantine or medieval material has been recovered, indicating that occupation ceased following the Roman phase. In summary, Trojanov Grad represents one of the rare Serbian hillforts preserving substantial Early Iron Age stone architecture, as well as a brief phase of late antique fortification.

MATERIALS AND METHODS

During the survey of the archaeological site of Trojanov Grad, the following equipment was employed (**Figure 2**):

DJI MATRICE 350 RTK – One of the latest unmanned aerial vehicles (UAVs) from the DJI Enterprise series, designed for multifunctional use across a range of professional sectors. Its principal advantage lies in the integration of an advanced Real-Time Kinematic (RTK) positioning system, which ensures high spatial accuracy. This UAV is particularly noteworthy for its ability to maintain flight stability under demanding environmental and operational conditions—an essential feature for the precise acquisition of spatial data (Tanimi and Toth 2024: 422).

DJI ZENMUSE L2 – This sensor system integrates a LiDAR unit with a high-precision Inertial Measurement Unit (IMU) and an RGB camera equipped with a 4/3 CMOS sensor. This configuration allows for data acquisition with a vertical accuracy of 4 cm and a horizontal accuracy of 5 cm. The system is capable of detecting objects at distances of up to 250 metres, enabling the production of high-resolution Digital Elevation Models (DEMs) and facilitating penetration through dense vegetation from considerable distances (Tanimi and Toth 2024: 422–423).

In the subsequent phase of the project, a series of test flights was carried out to evaluate a range of operational parameters using the

Figure 2. DJI Matrice 350 RTK with Zenmuse L2 camera. (Photo by P. Milojević).

DJI Pilot 2 application. This software supports both autonomous and manual control of the UAV during mission execution. The primary aim was to determine which parameter configurations would yield the most accurate results for post-flight data analysis. We did not use any ground control points to validate the georeferencing of the point clouds, relying solely on RTK corrections. A total of four flights was conducted, during which various parameters were systematically adjusted. Recordings were carried out in December 2024, when the deciduous tree cover on Mount Cer was at its minimum.

Parameters used during the survey were:

Mission 1

Flight height	*50 m*
Average flight speed	*3 m/s*
Point cloud density	*943 m²*
DEM resolution	*1.67 cm/px*
Flight duration	*8:45 min*
Area	*35,000 m²*

Mission 2

Flight height	*50 m*
Average flight speed	*13 m/s*
Point cloud density	*228 m2*
DEM resolution	*1.71 cm/px*
Flight duration	*4:14 min*
Area	*35,000 m²*

Mission 3

Flight height	*100 m*
Average flight speed	*13 m/s*
Point cloud density	*109 m²*
DEM resolution	*3.03 cm/px*
Flight duration	*2:19 min*
Area	*35,000 m²*

Mission 4

Flight height	*100 m*
Average flight speed	*3 m/s*
Point cloud density	*471 m²*
DEM resolution	*3.09 cm/px*
Flight duration	*4:07 min*
Area	*35,000 m²*

For data processing, DJI Terra, version 4.4.6, one of the latest software platforms specifically designed for compatibility with DJI equipment, was employed. This advanced mapping and modelling tool enables rapid and accurate generation of maps and 3D models. The software includes a comprehensive suite of auxiliary functions that streamline the image processing workflow. Its visualization tools allow for detailed examination of point clouds, effectively highlighting subtle terrain variations, even beneath dense vegetation. DJI Terra is particularly well-suited to contexts where data must be processed efficiently without compromising on precision and accuracy (Tanimi and Toth 2024: 423; Jarahizadeh and Salehi 2024). DJI Terra performs automatic point cloud classification when processing LiDAR data, distinguishing ground, vegetation, buildings, and power lines using AI-assisted algorithms. The results can be manually refined to improve digital terrain models or exported for further analysis in specialized software. However, this feature applies only to LiDAR-based point clouds, and its precision depends on flight parameters and terrain complexity (DJI 2024).

RESULTS AND DISCUSSION

As previously mentioned, DJI Terra offers a wide array of tools for data processing and analysis. However, in this study, the results are presented using the software's basic toolset, which includes:

RGB. The visible spectrum, interpreted here after vegetation removal and applied to all subsequent images. The first two images (**Figure 3**) were captured from an altitude of 50 metres at different flight speeds—**Figure 3/1** at 3 m/s and **Figure 3/2** at 13 m/s. In both cases, a lower-quality point cloud was produced. Deficiencies are particularly evident along the edges of the point cloud, especially in areas of lower elevation, while the central sections show sporadic gaps. These deficiencies are more pronounced in the second image, where the higher flight speed resulted in fewer automatically collected points and reduced detail, ultimately affecting the point cloud's quality during processing. Despite these limitations, both images clearly reveal the location of the fortress and the orientation of its defensive walls.

The third and fourth images (**Figures 3/3 and 3/4**), taken from a height of 100 metres at the same respective flight speeds as the earlier images (13 m/s and 3 m/s), produced significantly higher-quality point clouds. Apart from a visible gap in the north-western portion, the deficiencies in the central area were almost negligible. As in the earlier examples, the slower flight speed in **Figure 3/4** allowed for the collection of a greater number of points and more detail, enhancing the quality of the resulting point cloud. The fortress layout and the direction of its defensive walls are more distinctly visible in **Figures 3/3 and 3/4** compared to **Figures 3/1 and 3/2**. Additionally, the remains of a polygonal tower on the northern side of the fortress can be faintly discerned.

The increased camera height in **Figures 3/3 and 3/4** resulted in a narrower field of view, which concentrated the data collection on a smaller area, improving the density and quality of detail. Combined with slower flight speeds, this produced a higher point density and, thus, better image quality during post-processing.

In the final stage of data processing, all four images were combined to generate the highest-quality point cloud (**Figure 3/5**). Specifically, the broader overviews (**Figures 3/1 and 3/2**) were merged with the more focused images (**Figures 3/3 and 3/4**). While some edge deficiencies from the first two images remained, they were significantly reduced by incorporating additional points from the third and fourth images. The overlapping of multiple images helped fill earlier gaps, particularly in the central areas, where deficiencies had been more noticeable.

The final composite image offers a much clearer visualization of the fortress's defensive wall, especially on its eastern and southern sides. The polygonal tower is now clearly outlined, and even the remnants of a double defensive wall along the southern side can be discerned.

Intensity. Intensity represents the strength of the laser pulse reflected back to the LiDAR sensor and indicates how well a surface reflects the laser. It is used to differentiate between materials and assess surface characteristics, aiding in the classification and quality control of the point cloud.

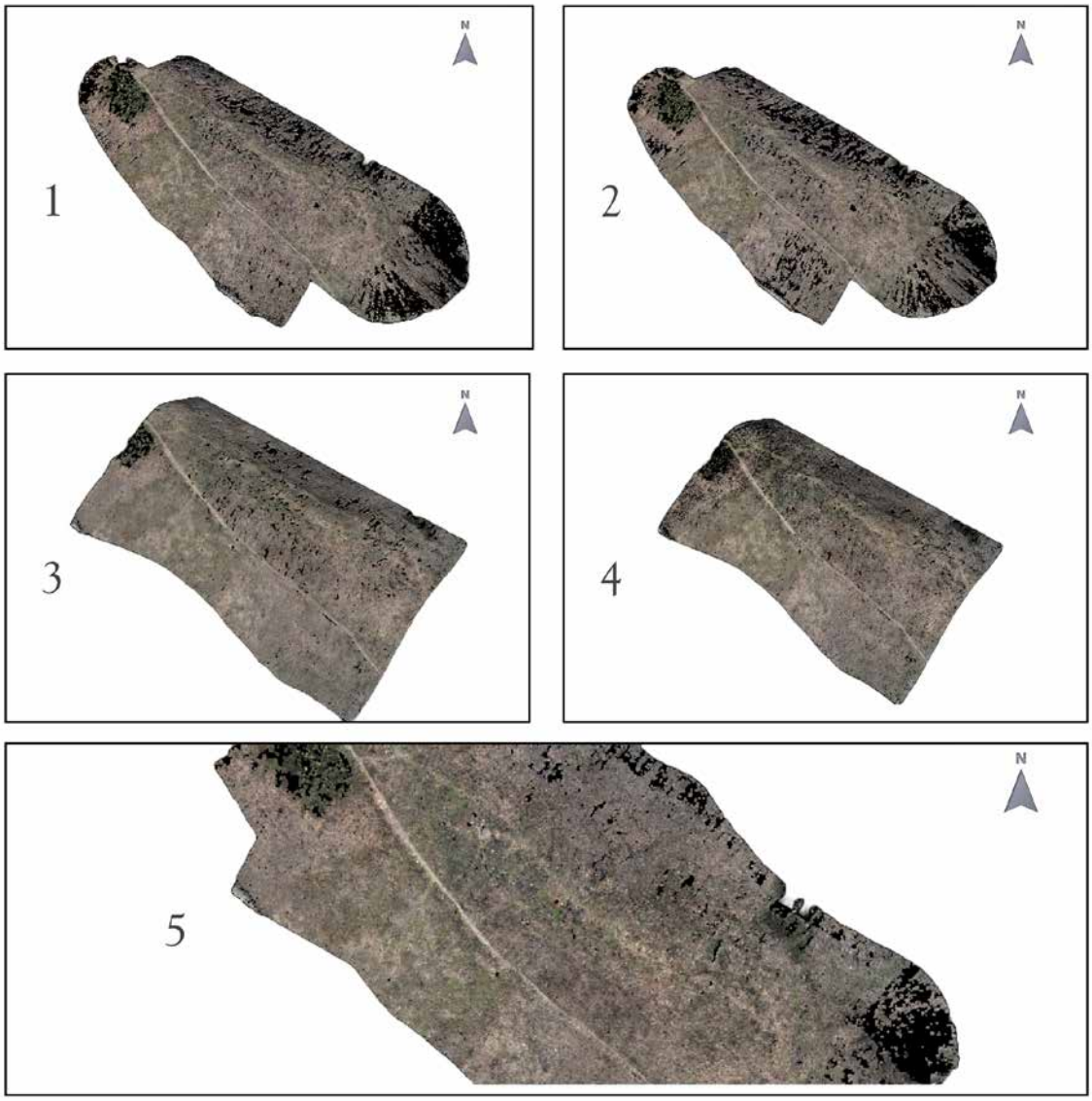

Figure 3. RGB model of the site of Trojanov Grad, all four recordings and combined model.

For further processing, the same point cloud previously analysed using the RGB tool was utilized. Additional analysis was conducted using the slope-degree visualization tool, which highlights elevation gradients. In the first two images (**Figures 4/1 and 4/2**), captured from a height of 50 metres, the central portion of the fortress plateau (marked in green) stands out clearly. The western edge of the defensive wall is distinctly visible and marked in orange, while the remainder of the image features a blend of the two colours, with orange more prominent along the wall's edges.

In the third and fourth images (**Figures 4/3 and 4/4**), taken from 100 metres altitude, the quality of the point cloud renders the defensive walls clearly visible, with a constant interplay of three colours—green, orange, and blue. These colour distinctions allow for the partial identification of the eastern defensive wall, where orange again dominates along the edges. When all four images are combined (**Figure 4/5**), the central plateau area (green) is sharply delineated, along with the western, and partially the northern and southern, edges of the defensive wall. The remainder of the image continues to reflect a mix of colours, with orange concentrated along wall

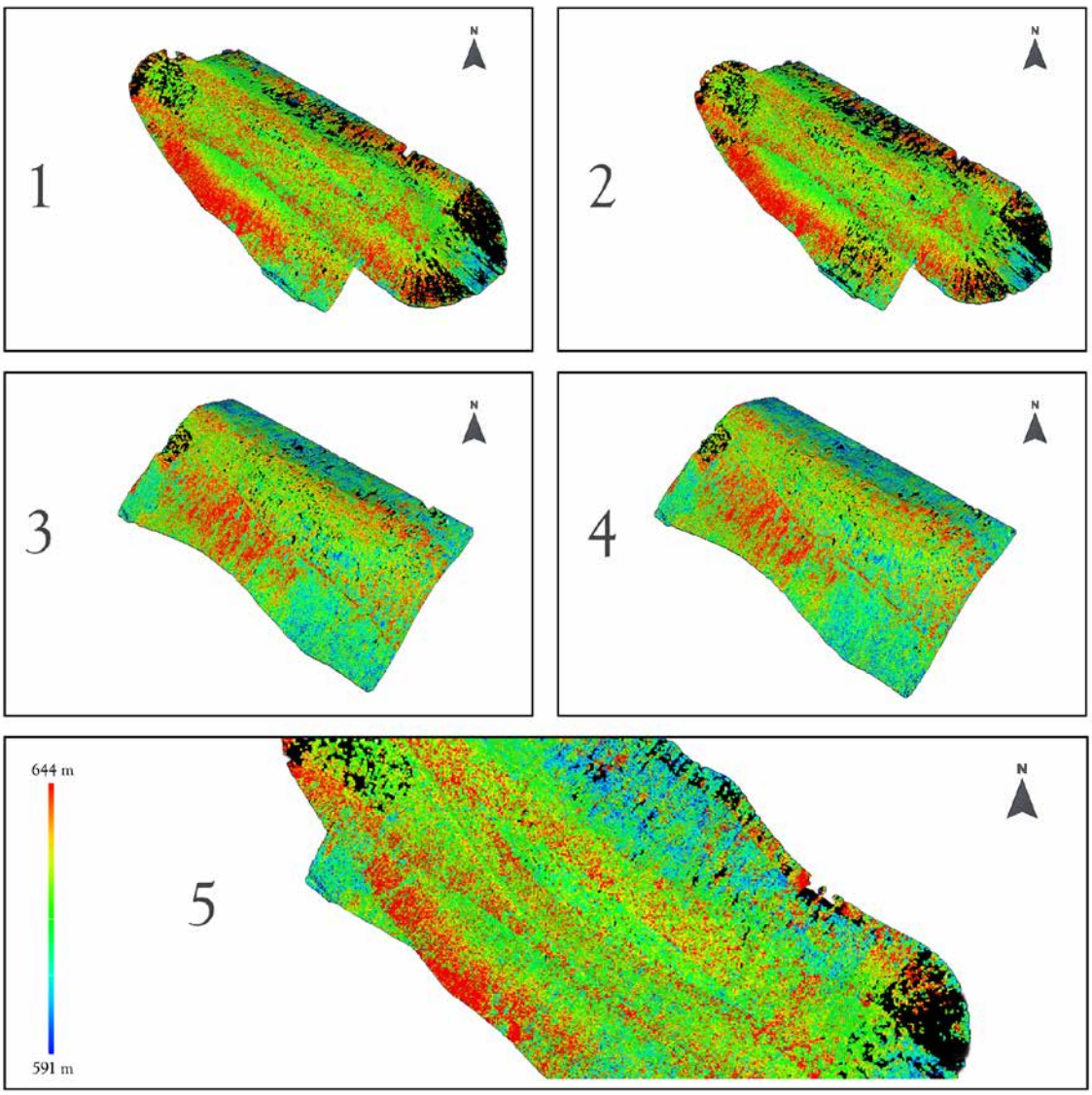

Figure 4. Intensity model of the site of Trojanov Grad, all four recordings and combined model.

boundaries and slopes predominantly represented in blue.

Height. This tool displays vertical differences in elevation across the visible spectrum. The quality of the point cloud directly influences the image quality generated by the height tool. In this case, the best visibility was achieved by combining all four images (**Figure 5**). Across all the images, elevation differences are displayed using a colour gradient (from blue for the lowest elevations through green, yellow, and orange, to red for the highest). This visual spectrum highlights the course of the defensive wall, the plateau, the double southern defensive wall, the prehistoric moat, and the ancient polygonal tower on the northern side. The internal circulation within the plateau is also particularly evident when all four images are merged.

Type. This refers to the classification of LiDAR points within the dataset. LiDAR data is typically categorized based on return signals, point density, or detected surface characteristics. Classifications include:

- Type 2: Ground points (representing the Earth's surface)
- Type 3: Vegetation points
- Type 6: Building points
- Type 1: Unclassified points

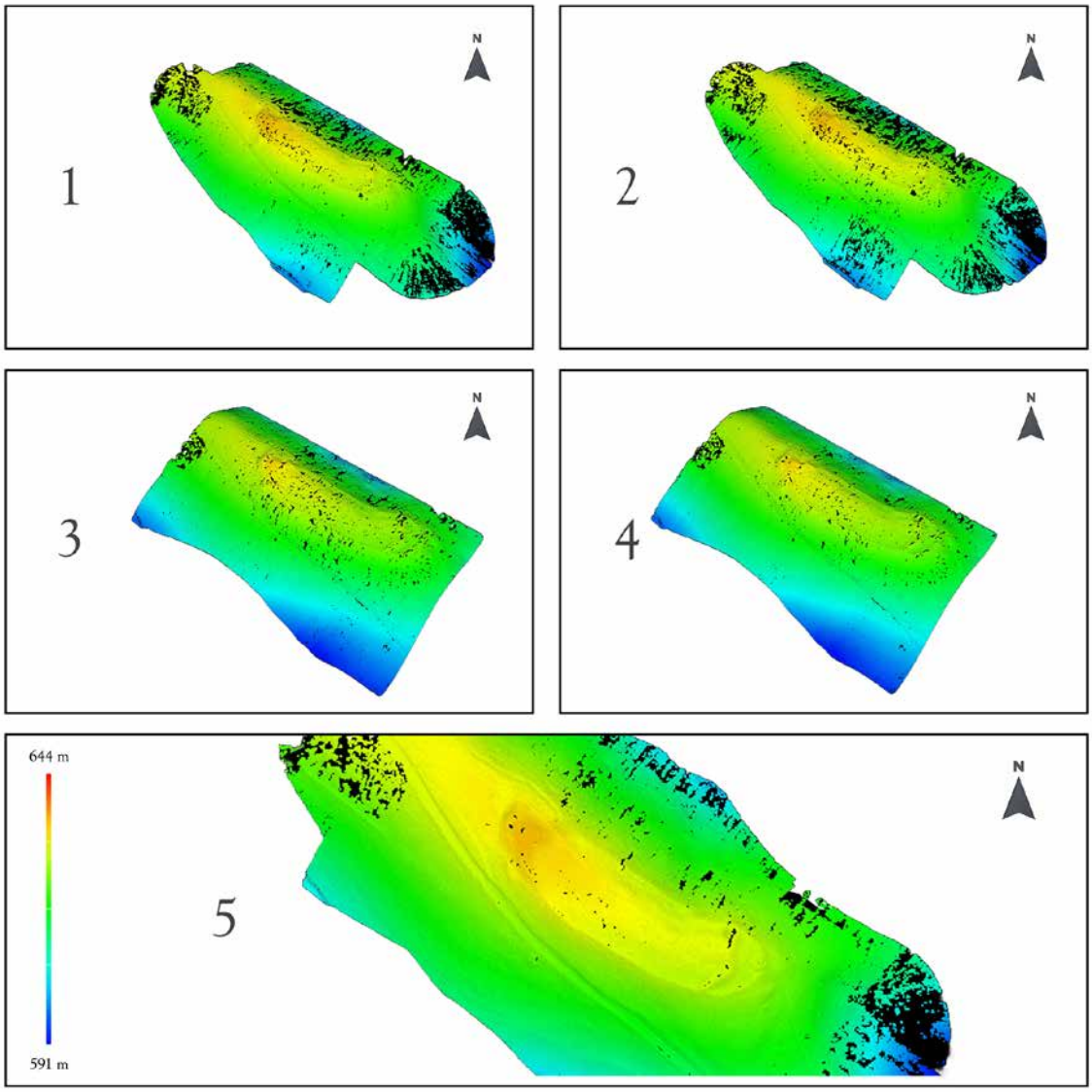

Figure 5. Height model of the site of Trojanov Grad, all four recordings and combined model.

Each classification corresponds to a specific feature or surface element identified in the scan, helping to differentiate the various components of the surveyed environment (**Figure 6**).

The Type tool produces a visualization similar to the Height tool, with the entire image rendered in orange. As with the previous tool, the communication paths and northern moat are most distinctly represented when all four images are combined.

DEM. Digital Elevation Model (DEM), or digital terrain model. Within the DJI Terra software, the DEM tool provided the clearest representation of the surveyed terrain (**Figure 7**). In the first two images (**Figures 7/1 and 7/2**), captured from 50 metres altitude, all previously identified features of the fortress—the defensive wall, plateau, double wall on the southern side, polygonal tower and moat on the northern side, and internal communication routes—are clearly distinguishable. As expected, the image clarity is somewhat greater in **Figure 7/1**, captured at a lower flight speed.

In both images, deficiencies in the point cloud are evident as blurred pixels and occasional artifacts, such as conical distortions resulting from the presence of tall trees, especially in lower-elevation zones. In the third and fourth

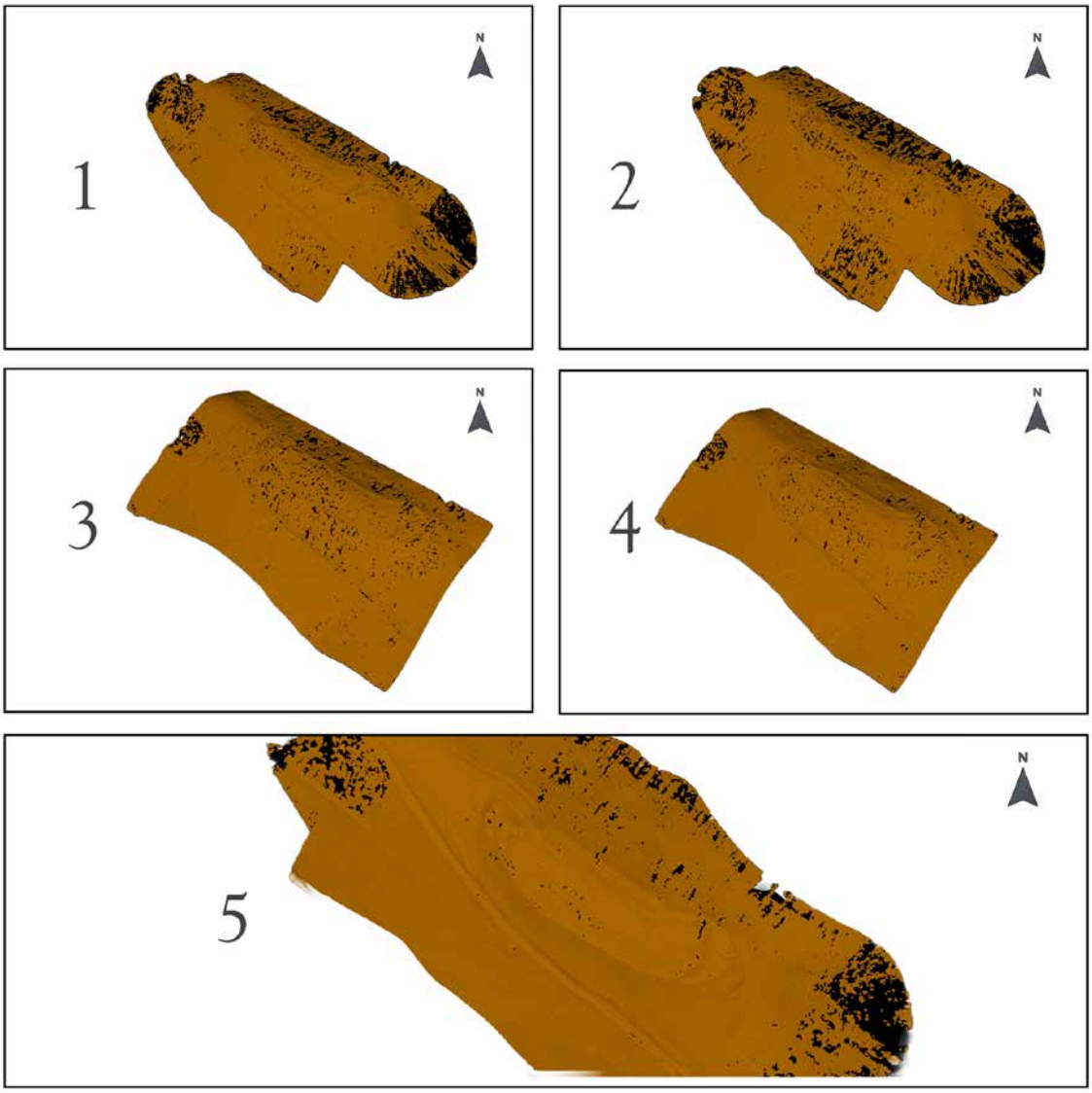

Figure 6. Type model of the site of Trojanov Grad, all four recordings and combined model.

images (**Figures 7/3 and 7/4**), the details are again sharper in the fourth image, captured at lower speed, where these distortions are absent.

Notably, a few circular depressions were observed—possibly linked to modern stone extraction or historical mining activities—particularly on Mount Cer. These features, however, require confirmation through fieldwork.

The integration of all four images yielded a highly detailed and accurate visualization of the fortress (**Figures 7/5 and 8**). While the circular depressions identified in the third and fourth images are clearly visible, the deficiencies seen in the first two (blurred pixels and conical distortions) persist, but only in non-overlapping areas. To further enhance the interpretative clarity, a new processing chain was applied in QGIS using the Relief Visualization Toolbox, prioritising the Simple Local Relief Model (SLRM), rather than standard tools in QGIS. These advanced visualisations are increasingly recognised as more appropriate for archaeological prospection because they remove directional bias, enhance subtle micro-relief features, and reduce artefacts caused by light source orientation (Hesse 2010: 67–72; Guyot *et al.* 2021: 15–20). The newly generated model is exceptionally clear and well-suited to archaeological interpretation: all the same

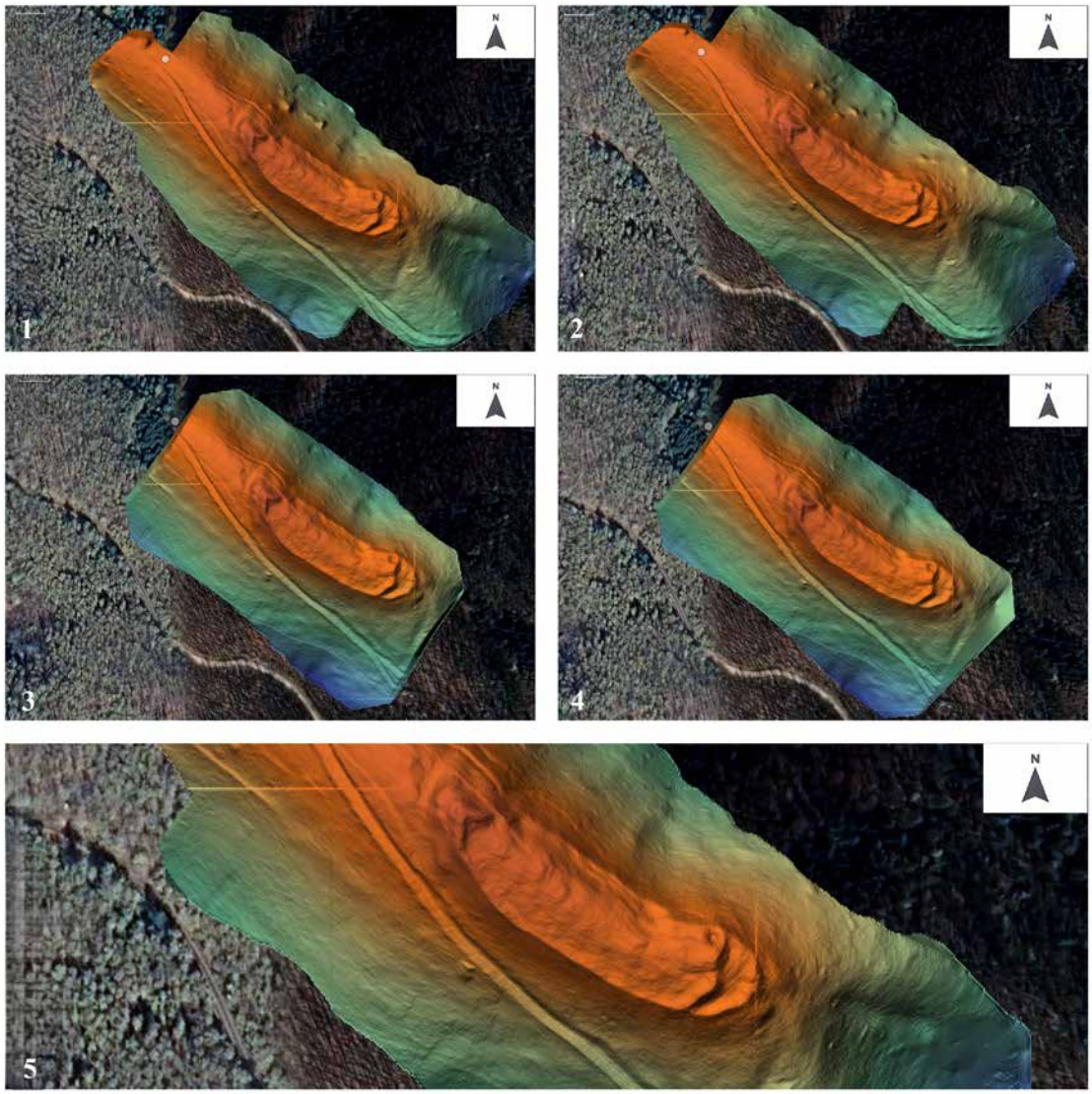

Figure 7. DEM model of the site of Trojanov Grad, all four recordings and combined model.

features previously detected (ramparts, ditches, towers and structural depressions) are reproduced, but now with heightened definition and contrast, making them far easier to identify, digitise, and analyse (**Figure 9**). Thus, the SLRM-derived output substantially improves on the original visualisation and provides a more reliable basis for mapping the fortress morphology and supporting the wider morphological and typological analysis of the boundary installations. These enhanced visualisations ensure significantly greater accuracy in the depiction of micro-relief features, reducing interpretative ambiguity and improving spatial precision in archaeological mapping. In particular, the SLRM output allows structural elements to be showcased with high clarity and definable boundaries, thereby reinforcing confidence in digitisation and subsequent typological analysis.

CONCLUSION

The application of the UAV-LiDAR survey has proven transformative in documenting Trojanov Grad, which is heavily obscured by a dense forest canopy. Multiple drone flights using modern rotary-wing platforms produced centimetre-resolution point clouds and digital terrain models. By varying flight parameters and integrating

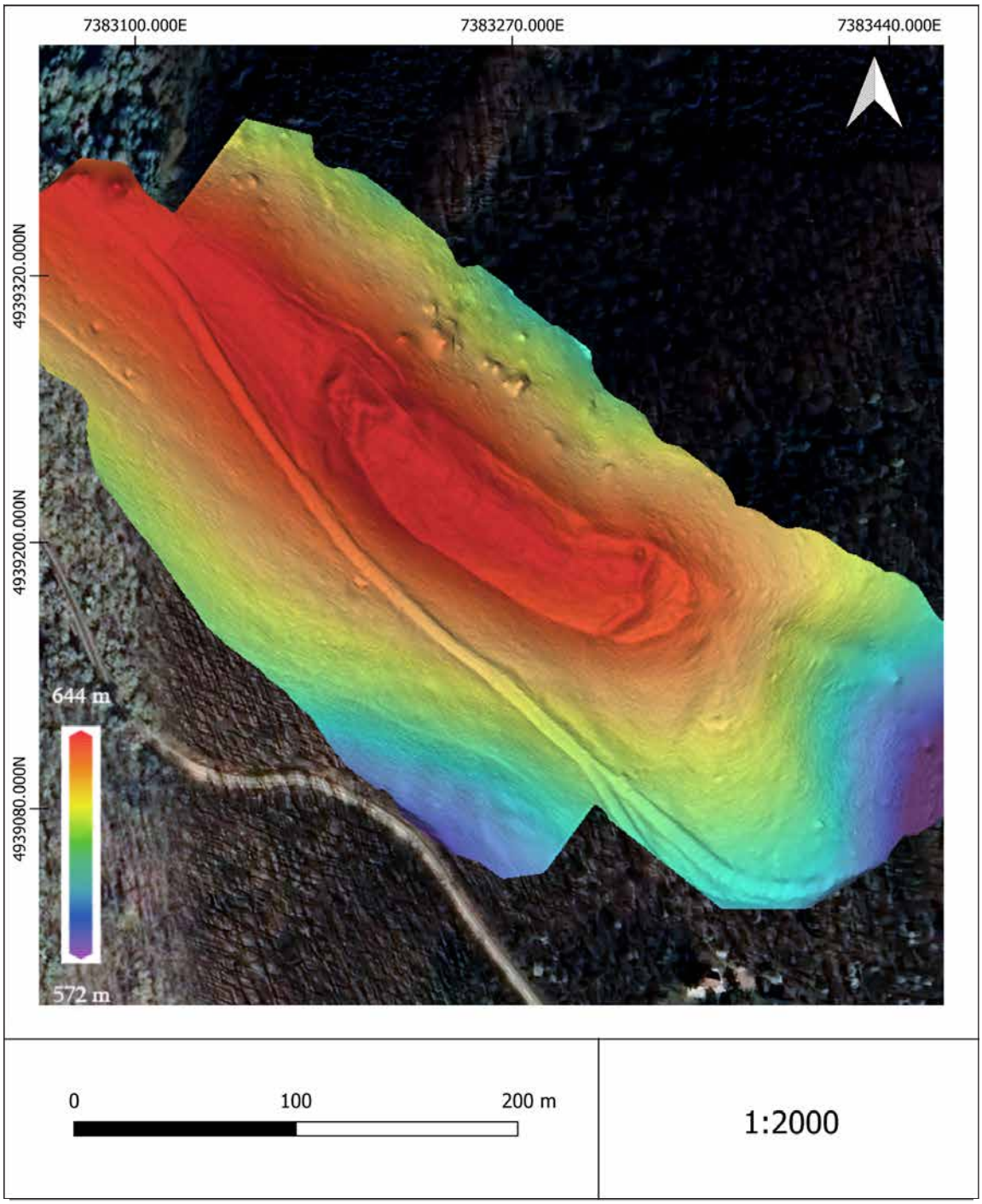

Figure 8. Satellite image combined with DEM of the site of Trojanov Grad.

overlapping surveys, researchers achieved a remarkably clear topographic reconstruction of the site. Features such as the interior and exterior edges of the rampart, the defensive ditch, the polygonal base of the Roman tower, and even subtle circular depressions—possibly linked to quarrying or mining—became visible in the LiDAR-derived models (**Figure 10**). These results echo Caspari's observation that airborne LiDAR can "reveal subtle anthropogenic features" beneath vegetation, dramatically enhancing archaeological mapping in forested environments. In practice, the multi-pass LiDAR method effectively overcame sensor shadow and registration errors on the steep

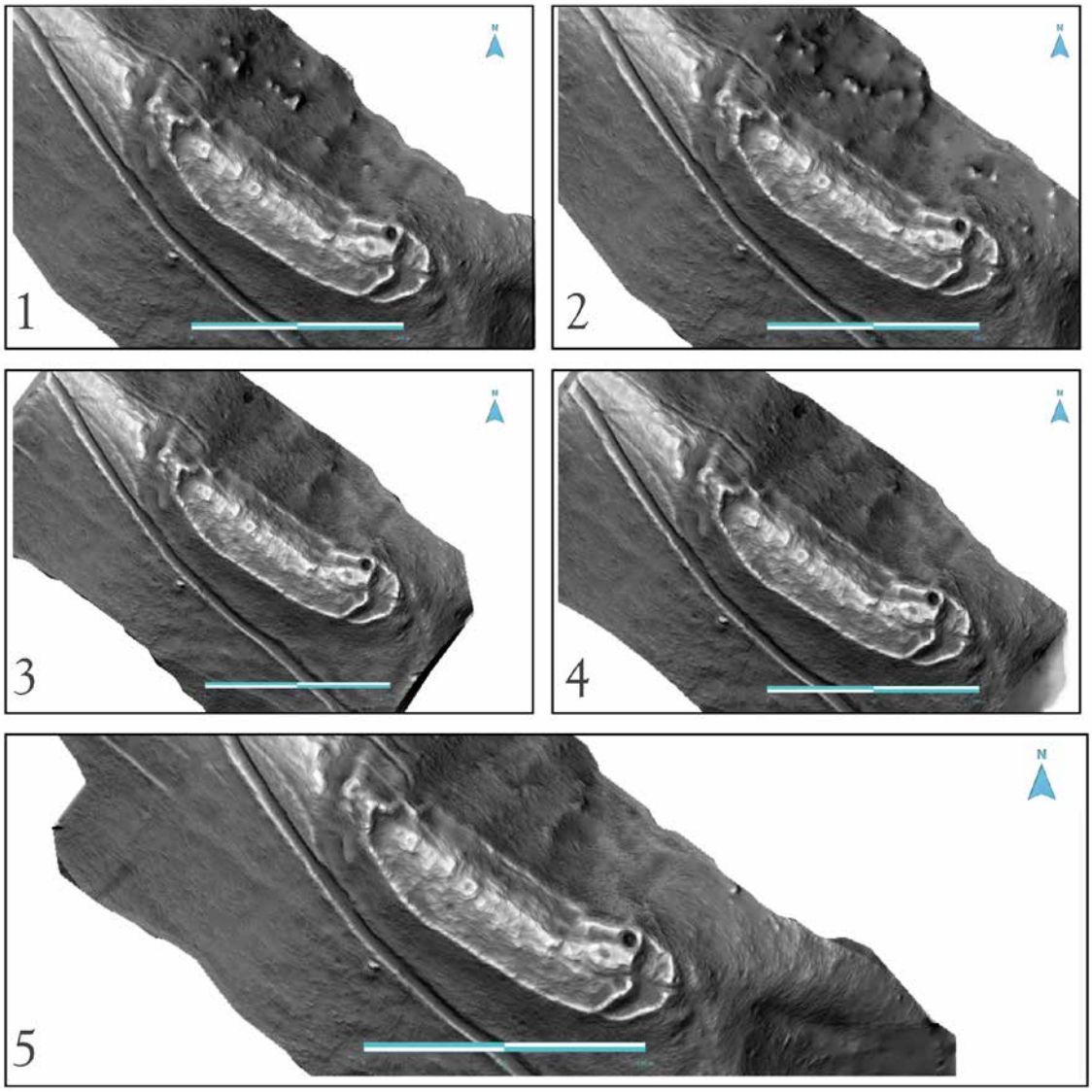

Figure 9. Local Relief Model of the site of Trojanov Grad, all four recordings and combined model.

slopes of Mount Cer, enabling accurate mapping of fortification walls and terraces that would otherwise remain undetected from ground level.

Although initially conceived as a smaller fortification in the hinterland of the province—primarily intended to ensure the uninterrupted exploitation of precious metals—the site of Trojanov Grad exhibits comparable architectural features to larger, better-known sites. Based on the analysis of a digital elevation model (DEM), in addition to the north-western tower identified during the 2014 campaign, two further towers—most likely polygonal in form—can now be added to the overall plan (**Figure 11**). These are located in the south-eastern sector, serving primarily to defend the fort's sole entrance. In front of the gateway, the remains of a bastion—an additional reinforcement of the south-eastern section of the fortification—are also visible. This interpretation is supported not only by the DEM but also by a cross-sectional terrain profile, which indicates a rise in ground elevation at points corresponding to the presumed location of the ramparts (**Figure 12/1–2**). Given the site's topography and steep slopes, the north-eastern and south-western walls did not require additional reinforcement.

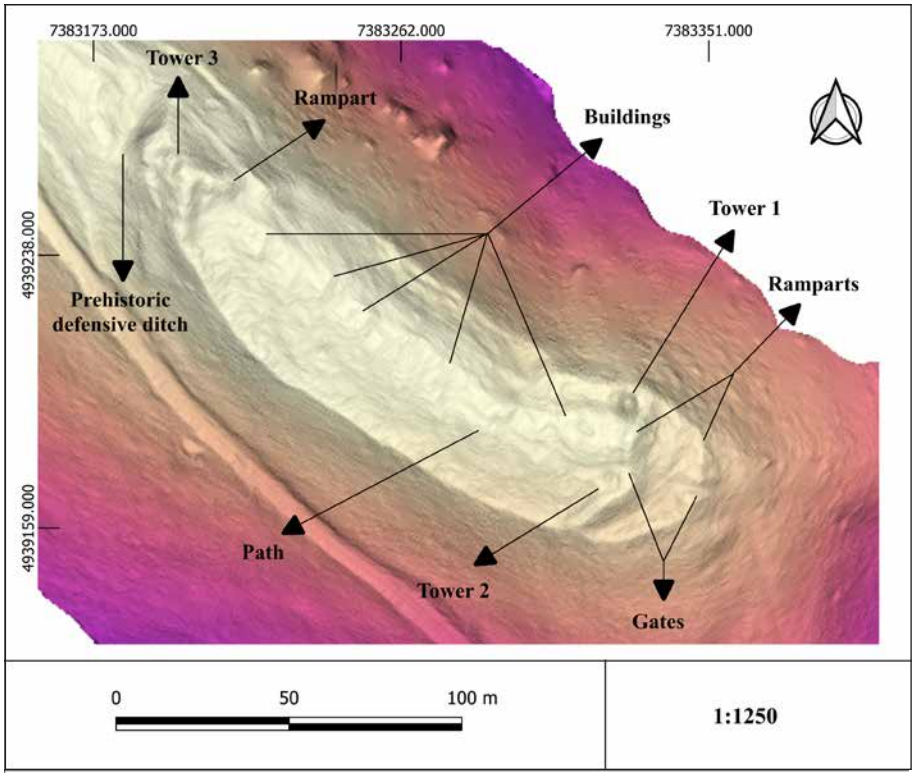

Figure 10. The rudimentary layout of the architectural and defensive characteristics at the site of Trojanov Grad.

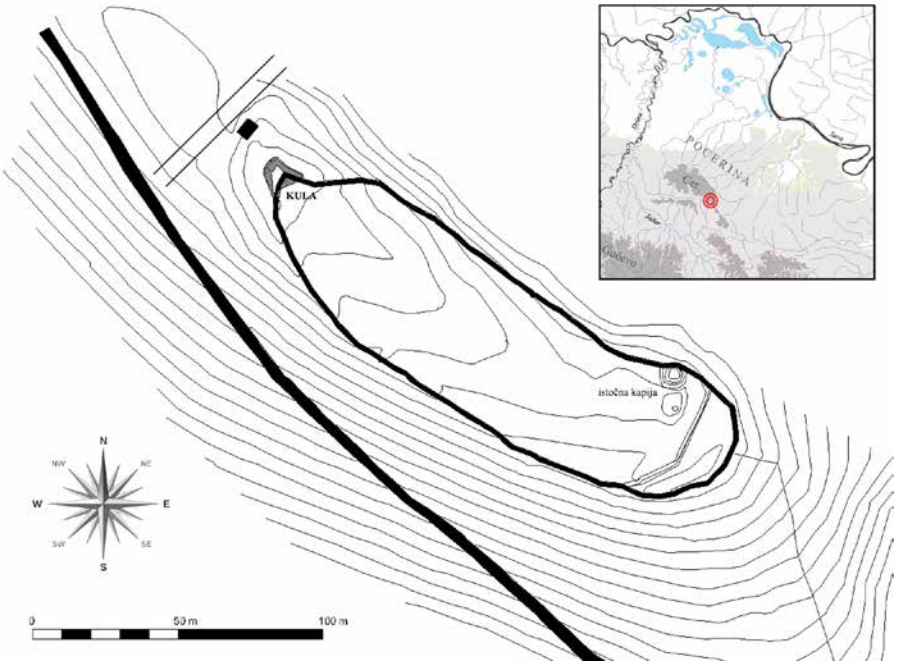

Figure 11. Plan of Trojanov Grad, 2014. (After: Bulatović i dr. 2017).

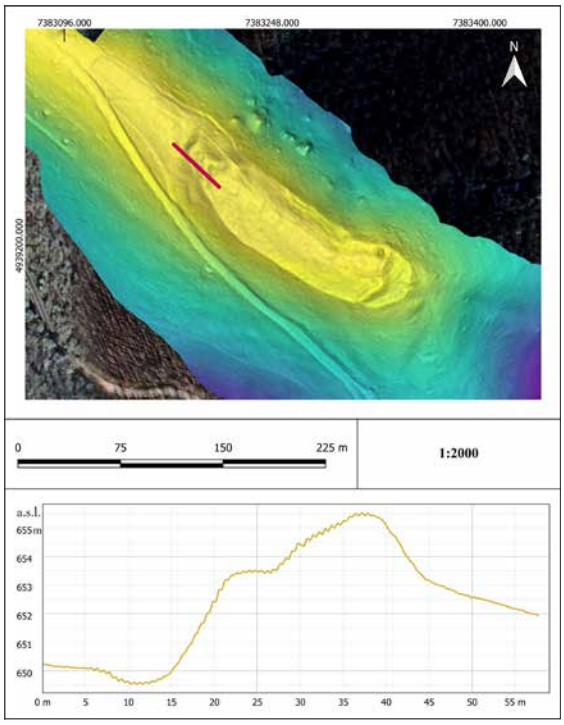

Figure 12.1. Elevation profile of the north-western part of the rampart.

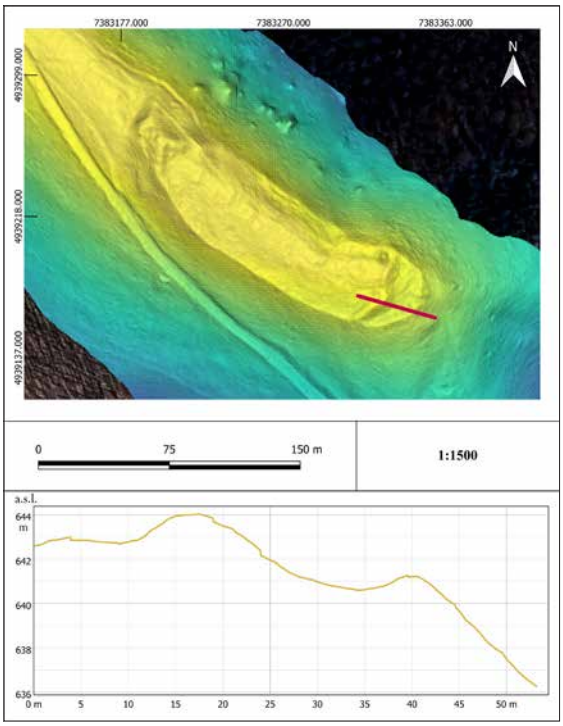

Figure 12.2. Elevation profile of the south-eastern part of the rampart.

Methodologically, the Trojanov Grad case exemplifies how integrating remote sensing technologies can significantly advance regional archaeological research. The success of the UAV-LiDAR at this site—building on recent studies across the Balkans—demonstrates that dense forest is no longer a barrier to systematic settlement survey. For western Serbia, this implies that numerous little-known hillforts and ancient roadways may now be identified and documented through similar techniques. The study, thus, contributes to a refined understanding of settlement networks in the Cer region, illuminating both their economic foundations and the methodological approaches necessary for their recovery in densely wooded terrain.

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REZIME

TROJANOV GRAD – METODOLOŠKI PRISTUP I ANALIZA PODATAKA DOBIJENIH IZ NIZA SNIMAKA NASTALIH LIDAR METODOM

KLJUČNE REČI: TROJANOV GRAD, PLANINA CER, KASNO BRONZANO DOBA, RANO GVOZDENO DOBA, KASNA ANTIKA, METODOLOGIJA, BESPILOTNE LETELICE, DALJINSKA DETEKCIJA, LIDAR SISTEM, DJI

Trojanov grad predstavlja arheološki lokalitet gradinskog tipa, koji je pozicioniran na istočnim padinama planine Cer, na nadmorskoj visini od 607 metara. Lokalitet se pruža duž dominantnog platoa dimenzija 250 x 80 metara. Sam pristup na prostrani plato omogućen je sa istočne i zapadne strane, dok su severna i južna strana zaštićene strmim padinama. Položaj utvrđenog mesta omogućava dominaciju nad širim geografskim prostorom, koji obuhvata Pocerinu, istočne delove Jadra i jugoistočne predele Mačve. Ovaj lokalitet često se pominje u zapisima ranih hroničara i putopisaca, najčešće u kontekstu naseljavanja za vreme rimske dominacije i srpske srednjevekovne države. Međutim, arheološka iskopavanja, sprovedena u više navrata u prethodnoj deceniji, pored kasnoantičkog horizonta, potvrdila su i postojanje bogatog kulturnog sloja koji se hronološki svrstava u prelazno razdoblje između bronzanog i gvozdenog doba. Dodatna istraživanja ukazuju na kontinuitet naseljenosti i kompleksnost stratigrafije, što svedoči o značaju lokaliteta tokom više istorijskih epoha.

Uprkos tradicionalnim istorijskim i arheološkim podacima, kompleks Trojanovog grada nikada nije mogao biti sagledan u celosti, pre svega zbog guste i neprobojne šumske vegetacije koja prekriva padine planine Cer. Ova prirodna barijera dugo je onemogućavala preciznu kartografsku i prostornu analizu lokaliteta. Međutim, savremeni tehnološki napredak, pre svega u razvoju računarskih programa, geoprostornih alata i upotrebi bespilotnih letelica, znatno je unapredio primenu metoda daljinske detekcije u arheologiji. Takve metode omogućile su ne samo lakšu identifikaciju i dokumentaciju arheoloških struktura već i njihovu analizu u širem prostornom kontekstu. Posebno se izdvaja LiDAR (Light Detection and Ranging) tehnologija, kao jedna od najefikasnijih metoda daljinske detekcije, koja sve više nalazi primenu u interdisciplinarnim istraživanjima arheoloških lokaliteta, pružajući mogućnost trodimenzionalnog snimanja terena i otkrivanja skrivenih struktura nevidljivih klasičnim metodama terenskog rada. Reč je o laserskom skeniranju Zemlje, preko sistema za snimanje iz vazduha. Upotreba ovakvog sistema omogućava prikupljanje podataka koji obezbeđuju veliki broj informacija o snimanom objektu, pojavama i procesima na površini Zemlje sa velikom gustinom trodimenzionalnih koordinata tačaka, pomoću lasera.

U procesu samog snimanja arheološkog lokaliteta Trojanov grad, korišećena je sledeća oprema: DJI MATRICE 350 RTK – koja predstavlja jednu od najnovinih bespilotnih letelica iz DJI Enterprise serija, dizajnirana za višenamensku ulogu u različitim profesionalnim segmentima, potom kamera ZENMUSE L2 – koja integriše LiDAR visokoprecizni IMU sistem i RGB kameru sa senzorom 4/3 CMOS. Ovakav sistem, omogućava prikupljanje podataka sa velikom preciznošću od 4 cm u visinu i 5 cm u horizontali. Dok je prilikom obrade podataka, korišćen program koji je posebno kompatibilan sa korišćenom DJI opremom, a reč je o gotovo novom programu na tržištu za obradu i analizu podataka DJI Terra verzija 4.4.6. Naime, reč je o naprednom softveru za mapiranje i modelovanje koji korisnicima omogućava veoma brzo i precizno dobijanje mapa i 3D modela. U okviru programa, postoji veliki niz pomoćnih alata koji sam proces obrade snimaka umnogome olakšavaju korisniku.

U metodološkom pristupu, odlučili smo se da testiramo različite parametre, koji se pre svega odnose na visinu i brzinu leta, u okviru serije letova. Na ovaj korak smo se odlučili kako bismo uvedeli koji parametri će se najbolje pokazati prilikom kasnije analize podataka. Parametri su menjani tokom serije letova, a ukopno ih je izvedeno četiri.

Upotrebom različitih ulaznih vrednosti u više ponovljenih letova i snimanja, omogućeno je otkrivanje elemenata koji nisu bili vidljivi u okviru jednog snimka. Uz korišćenje alata za obradu podataka u programima DJI Terra i QGIS, u radu su paralelno prikazani rezultati koji omogućavaju jasniju interpretaciju prostorne organizacije Trojanovog grada. Posebno značajnu ulogu u procesu analize imali su različiti modeli vizualizacije terena poput analize nagiba, poprečnog preseka reljefnih struktura, Topographic Position Index-a (TPI) i Local Relief Model-a (LRM), koji naglašavaju mikroreljefne varijacije ključne za prepoznavanje arheoloških struktura. Pored navedenog, primenjeni su i filteri za uklanjanje vegetacije i klasifikaciju terenskih tačaka, čime je poboljšana tačnost digitalnog modela elevacije. Kombinovanjem više vizualizacionih pristupa, ustanovljena je nova interpretacija arhitektonskih elemenata utvrđenja i znatno je unapređena čitljivost terena pod gustom šumskom vegetacijom. Rezultati ukazuju na dimenzije fortifikacije, pravac prostiranja bedema, kule i defanzivni rov, dok su uočljivi i položaji ranijih arheoloških istraživanja, što doprinosi boljem razumevanju prostornog plana, strukture i funkcije lokaliteta.

* * *

Use of tools based on large language models and generative AI: ChatGPT+ (initial proofreading); Grammarly (initial proofreading).

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MEDIEVAL CEMETERY AT THE SITE OF THE GIMNAZIJA HIGH SCHOOL COURTYARD IN ČAČAK, SERBIA

ABSTRACT

The paper presents the research results of a late medieval cemetery at the Gimnazija High School Courtyard site in Čačak, a city in Serbia. The western part of the cemetery, consisting of 19 graves with 20 inhumed individuals was discovered during rescue archaeological excavations, which were primarily aimed at defining the remains of the late antique horreum. The deceased were placed in grave pits dug through the horreum. They were in a supine position, oriented W – E, following the Christian burial ritual. Based on the deviation, two or, potentially, three groups of graves were assumed. Tests were carried out to obtain two AMS C14 dates from the human osteological material. The only certain grave find is a damaged bronze button from grave 4. The skeletons are relatively well preserved and have been preliminarily anthropologically analysed. Different age and sex groups with various pathologies are represented, testifying to the hard work and difficult living conditions of this population. The cemetery from the Gimnazija High School Courtyard along with other graves and cemeteries investigated in the centre of modern city of Čačak, contribute to a more detailed insight of medieval settlements established on the West Morava riverside, on the remains of a Roman fortification and its immediate surroundings.

KEYWORDS: ČAČAK, GIMNAZIJA HIGH SCHOOL COURTYARD, MEDIEVAL CEMETERY, C14 DATES.

INTRODUCTION

On the border between western and central Serbia, in the northern part of the West Morava river valley, immediately after its passage through the Ovčar-Kablar gorge, the city of Čačak is located. The modern city centre includes the historical core with a large number of buildings from the 19th and the first half of the 20th century, extending on an elevated plateau above the former riverbed of West Morava, dominated by a massive church built over the medieval foundations. The described area has been the location of frequent archaeological finds and excavations covering the Roman, medieval, Ottoman and more recent periods. A significant shift in the understanding of the type, extent and function of this space occurred during the extensive archaeological excavation done between 2022 and 2024, resulting in the discovery of a Roman fortification stretching across the top of this raised plateau, an area safe from flooding and suitable for settling. This discovery clarified the position and role of other structures already discovered (e.g., the *thermae*

and the *horreum*) which belonged to a settlement particularly developed during Late Antiquity on the outer side of the castrum (Дмитровић и Ћирковић 2024) (**Figure 1**).

The Roman and Late Roman ruins represented the basis for the development of medieval settlements and the formation of the ecclesiastical and political centre of the Serbian medieval Morava district (Калић 1993; Вукадин 1993: 102; Радичевић 2003: 236–238; Радисављевић, Булић и Војновић 2025). According to the results of recent excavations, the fort was partially adapted in the early Middle Ages, but in later centuries it was extensively dismantled and the material used for the new constructions (Дмитровић и Ћирковић 2024: 228). An echo of earlier structures was preserved in the name of Gradac, which has remained as an epithet of the church dedicated to the Virgin up to the present day (Virgin of Gradac or Bogorodica Gradačka in Serbian) (Вуловић 1993). Following the historiography, the church with the monastery was founded by the end of the 12th century as endowment of Prince Stracimir. During the succeeding centuries, the church remained at the core of the development of the settlement, an important point in the medieval road network (Калић 1993; Веселиновић 1993).

Figure 1. Map of the central part of the modern city of Čačak, with the assumed position of the Roman fortification (shaded in white) and buildings in its surroundings. Roman structures are marked in solid red, and medieval graves and cemeteries in yellow: 1 – The courtyard of the museum; 2 – Virgin of Gradac (today Church of the Ascension of the Lord); 3 – Mutapova Street; 4 – Gimnazija High School Courtyard; 5 – Roman baths; 6 – "Roman square"; 7 – No.44, Bate Jankovića Street (Map supplemented by the authors according to: Дмитровић и Ћирковић 2024, Сл.1).

In relation to the position of the fortification and today's church, the Gimnazija High School Courtyard site lies approximately 150 m to the east, on the plateau's edge, at a slightly lower altitude, above the former West Morava riverbed (**Figure 1/4**). In this area outside the fortification, a larger building complex was formed during the end of the 3rd and the beginning of the 4th century, most likely located along the communication of the E – W direction (decumanus), towards the crossing over the West Morava river (**Figure 1/3,4**) (Дмитровић и Ћирковић 2024: Сл. 1; Радовановић 1993: Сл. 1, 2). The rescue archaeological research was carried out from 2014 to 2018 within the fenced yard east of the school building, between Mutapova and Lomina Streets. A multi-layered site that encompassed the long period from Late Antiquity, through the Middle Ages and Ottoman period to the modern time was found during these excavations (Дмитровић и Вујадиновић 2014; Дмитровић и Вујадиновић 2015).

In order to comprehend more fully the medieval period and the population that lived in the settlements situated in the central parts of modern Čačak, this paper presents a part of a larger cemetery consisting of 19 graves with 20 buried individuals. The preliminary results of the anthropological analysis and two AMS C14 dates, contribute to the reconstruction of living conditions and allow a more accurate chronological interpretation of the burial contexts. Consequently, it determines in more detail the relationship with other cemeteries in the immediate vicinity and provides assumptions about the settlement.

MATERIALS AND METHODS

Archaeological and historical context

The Gimnazija High School Courtyard site was excavated over four archaeological rescue campaigns that mainly aimed, if possible, to complete the entire excavation of a Late Antique *horreum*. Besides its foundations, later structures of a residential and economic function, and 19 medieval graves were also discovered (Дмитровић и Вујадиновић 2014; Дмитровић и Вујадиновић 2015) (**Figures 2 and 3**).

The *horreum* was rectangular in shape, with external dimensions of 21.2 x 10.6 m, preserved mainly in the foundation zone and partial walls consisting of one to two rows of stones. The outer face was built of blocks made of yellow and pink sandstone, bound with lime mortar of a greyish tone. The *horreum* consisted of two rooms – Room 1 with a very high-quality floor made of hydraulic mortar, and the smaller Room 2 to the south, without a preserved floor. The building had subsequently added buttresses made of stone blocks and layers of bricks bound with lime mortar.

The damage to the *horreum* floor occurred during its repair – the drilling of a channel along Wall 1 and postholes along the central axis – but also during the subsequent, secondary use of the building in the second half of the 4th and early 5th century. This period is characterised by a large number of pits, of which those smaller in diameter were most likely used as postholes for the structures made of wood. These objects, possibly modest huts, were built inside the *horreum* Room 1, after the loss of its primary function and probable partial collapse.

The late antique phase was followed by a total abandonment. Reuse started with the establishment of a medieval cemetery and continued during the Ottoman and the more recent period. It is very likely that the Late Roman *horreum* during the late Middle Ages was, to a certain extent, no longer visible; an assumption based on the grave pits cut through its walls and fine mortar floor (**Figures 2 and 4**).

The discovered inhumation graves, prepared in accordance with the Christian mortuary ritual, inside and outside the Late Roman building belonged to a larger cemetery that spread further to the east, possibly beneath the modern buildings located on the very edge of the plateau above the ancient riverbed. Archaeological excavations largely encompassed this cemetary, but due to the fact that some graves stretched beneath the trench's edges (e.g., those that damaged Wall 3), these were not investigated (**Figure 4**). The aim of the excavation was, with the available resources, to define the ground plan of the *horreum*, which was necessary for the finalization of the technical documentation for the new school gym, resulting in the lack of any possibility to explore all surfaces

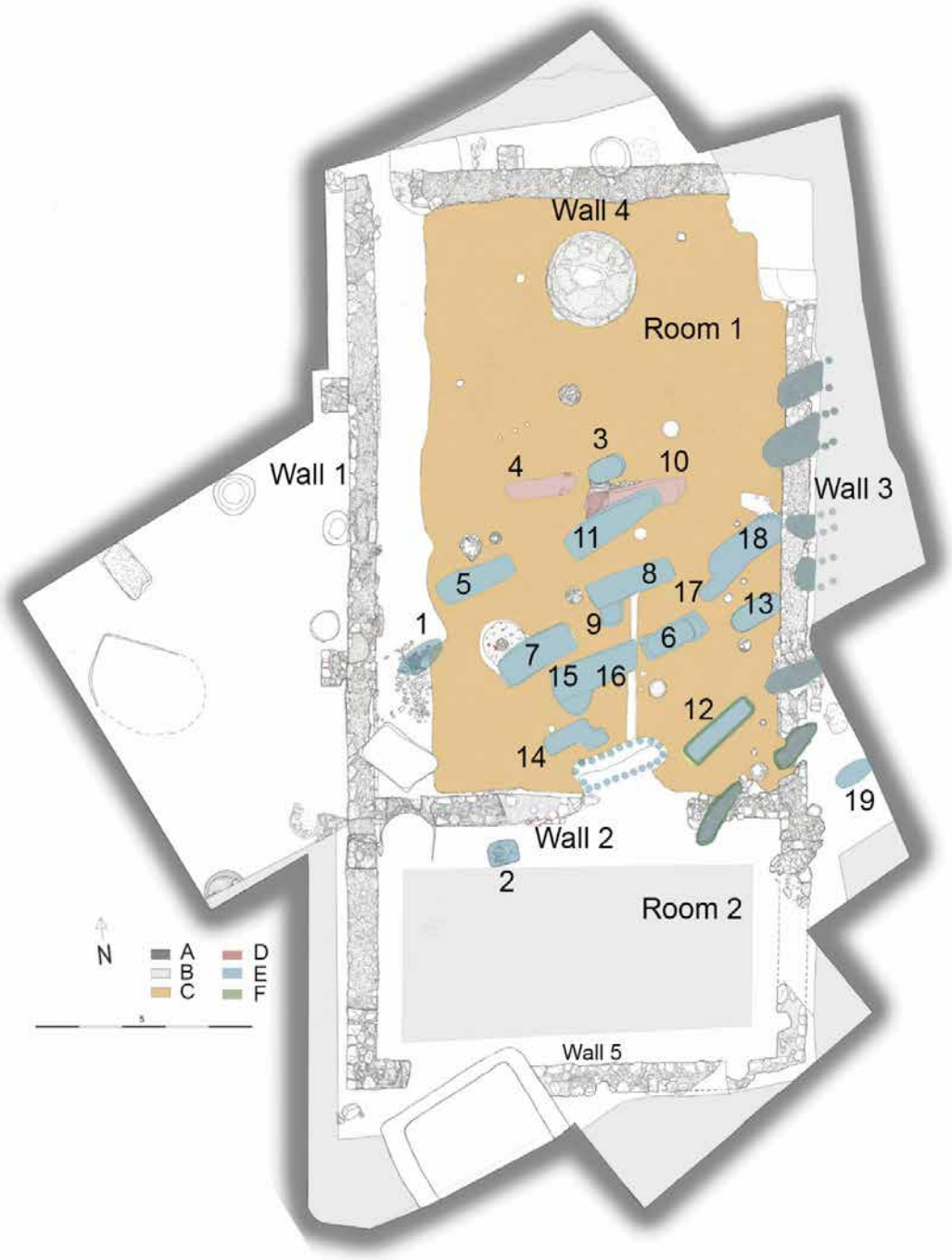

Figure 2. Plan of excavated area at the Gimnazija High School courtyard with the late antique *horreum* and medieval graves: A – Surfaces covered with asphalt; B – Unexplored surfaces; C – Mortar floor in *horreum* Room 1; D – 1st group of medieval graves; E – 2nd group of medieval graves; F – 3rd group of medieval graves. Presumed graves are coloured in grey-blue and have no number (Drawing according to Дмитровић и Вујадиновић 2015, supplemented by D. Ćirković and the authors).

in full (**Figure 2**, coloured in light grey and blue-grey). Until today, the *horreum* has remained only preliminarily protected and the planned construction works have not yet been undertaken (Дмитровић 2020).

Figure 3. Photograph of *horreum* and grave pits at the end of research in 2015 (according to Дмитровић и Вујадиновић 2015).

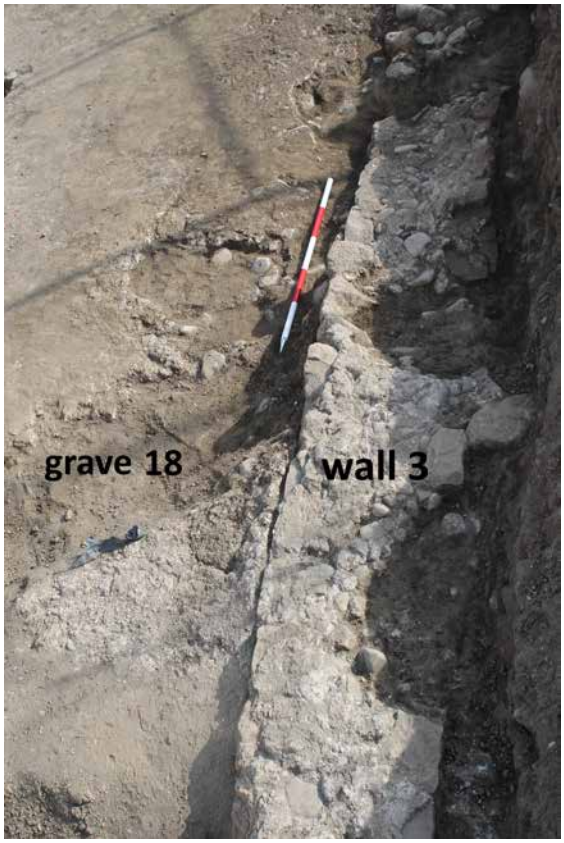

Figure 4. Photograph of *horreum* Wall 3 with burial pits in 2018 (documentation of the National Museum Čačak; photo: K. Dmitrović).

Human osteological analyses

The anthropological analysis was carried out by the associates of the Faculty of Biology and Faculty of Philosophy, University of Belgrade.[1] Their results used in this paper are preliminary, enabling a closer presumption of the living conditions and habits of this medieval population. The analysis refers to sex, age and some pathological issues.

The sex was determined primarily by the pelvis morphology (Phenice 1969; Ferembach, Schwidetzky and Stloukal 1980; Sjøvold 1988). Where the pelvis was not sufficiently preserved, the metric characteristics of the femur (Stewart 1979; Seidermann, Stojanowski and Doran 1998) and skull morphology were taken into consideration (Ferembach, Schwidetzky and Stloukal 1980; Bass 1995; Loth and Henneberg 1996). The sex of the children was not determined. Following the proposal of Roksandić and Armstrong (2011), individuals are defined into one of eight different stages of development/aging of the human skeleton:

[1] Dr Ksenija Đukić, research associate, Faculty of Biological Sciences, University of Belgrade analysed Grave 1, and Dr Predrag Radović, assistant professor, Faculty of Philosophy, University of Belgrade, analysed the rest of the graves. The analysis reports are kept in the National Museum in Čačak.

infantile stage, stages of early and late childhood, adolescence and four adult (adult) stages – young, full, mature and senile. When determining the age of children and adolescents, additional methods were applied: estimation of the age of subadults based on skeletal development (Scheuer and Black 2000), tooth development (Ubelaker 1999) and the length of the long bones of the limbs (Gindhart 1973; Jeanty 1983). For estimations of body height, regression equations based on a large Holocene sample of Europeans were used (Ruff *et al.* 2012). The body height estimates given as 95% were based on the maximum lengths of the long bones of the limbs. The skeletal remains were examined to determine the possible presence of palaeopathological changes (Prescher 1998; Ortner 2003; Waldron 2009) and non-metric (epigenetic) variations (Finnegan 1978; Brothwell and Zakrzewski 2004).

AMS C14 analyses

Current circumstances allowed the radiocarbon dating of two samples. These are of great importance, being among the first dated units in the wider area, but also valuable for comparison with other medieval radiocarbon dates from the graves and structures recently discovered within the Roman castrum.

The two radiocarbon dates from the cemetery at the the Gimnazija High School Courtyard site were taken from the bone material of the human skeletons in Grave 4 and 14. The selection of graves was made in accordance with their deviation from the W - E axis, the preserved condition of bone material and the presence of grave goods. Having these criteria, Grave 4 was considered suitable for two reasons: it belonged to the group of graves with the correctly oriented W-E axis and was furnished with a damaged bronze button. The other dated grave, Grave 14, was selected for belonging to another, more numerous group of graves with a larger deviation to the south.

Pre-treatment of bones implies collagen extraction, sealed tube combustion and sealed tube graphitization. The AMS analyses were prepared and analysed at the Isotoptech laboratory in Debrecen, Hungary.[2] The results obtained by this method are as follows:

Grave 4 (Sample ID - DeA 46485): Conventional C 14 age (yrs. BP ±1σ) - 1263±17;

2σ - 670-820 cal AD

1σ ranges: [cal AD 688: cal AD 698] 0.164831
[cal AD 702: cal AD 742] 0.825854
[cal AD 772: cal AD 774] 0.009315

2σ ranges: [cal AD 675: cal AD 752] 0.861723
[cal AD 757: cal AD 775] 0.101329
[cal AD 791: cal AD 799] 0.020867
[cal AD 811: cal AD 819] 0.016082

Grave 14 (Sample ID - DeA 46486) - Conventional C 14 age (yrs. BP ±1σ) 475±15;

2σ 1420-1450 cal AD

1σ ranges: [cal AD 1429: cal AD 1441] 1.

2σ ranges: [cal AD 1423: cal AD 1447] 1.

RESULTS

On the researched area at the Gimnazija High School Courtyard site in Čačak, a total of 19 graves were uncovered (Дмитровић и Вујадиновић 2014: 11; Дмитровић и Вујадиновић 2015: 8–9) with 20 individuals identified. The deceased were buried in accordance with the Christian funerary ritual – inhumation and orientated in a W – E direction, in a supine position, mostly with the hands placed over the chest or pelvis. The two graves, 4 and 10, were correctly oriented, and the others had a certain deviation towards the south. Overlapping and secondary positioning was registered in three cases. There were no grave finds except in Grave 4.

Grave 1. Inhumed deceased in the primary position with arms crossed on the chest, oriented W – E with a deviation of 8° to the south (**Figure 5/1**). The bones of lower limbs were later disturbed and some of them were found in layers above the grave. The edges of the grave pit were not

[2] More details on the methods of the analyses see: Molnár *et al.* 2013; Major *et al.* 2019a; Major *et al.* 2019b; Reimer *et al.* 2020.

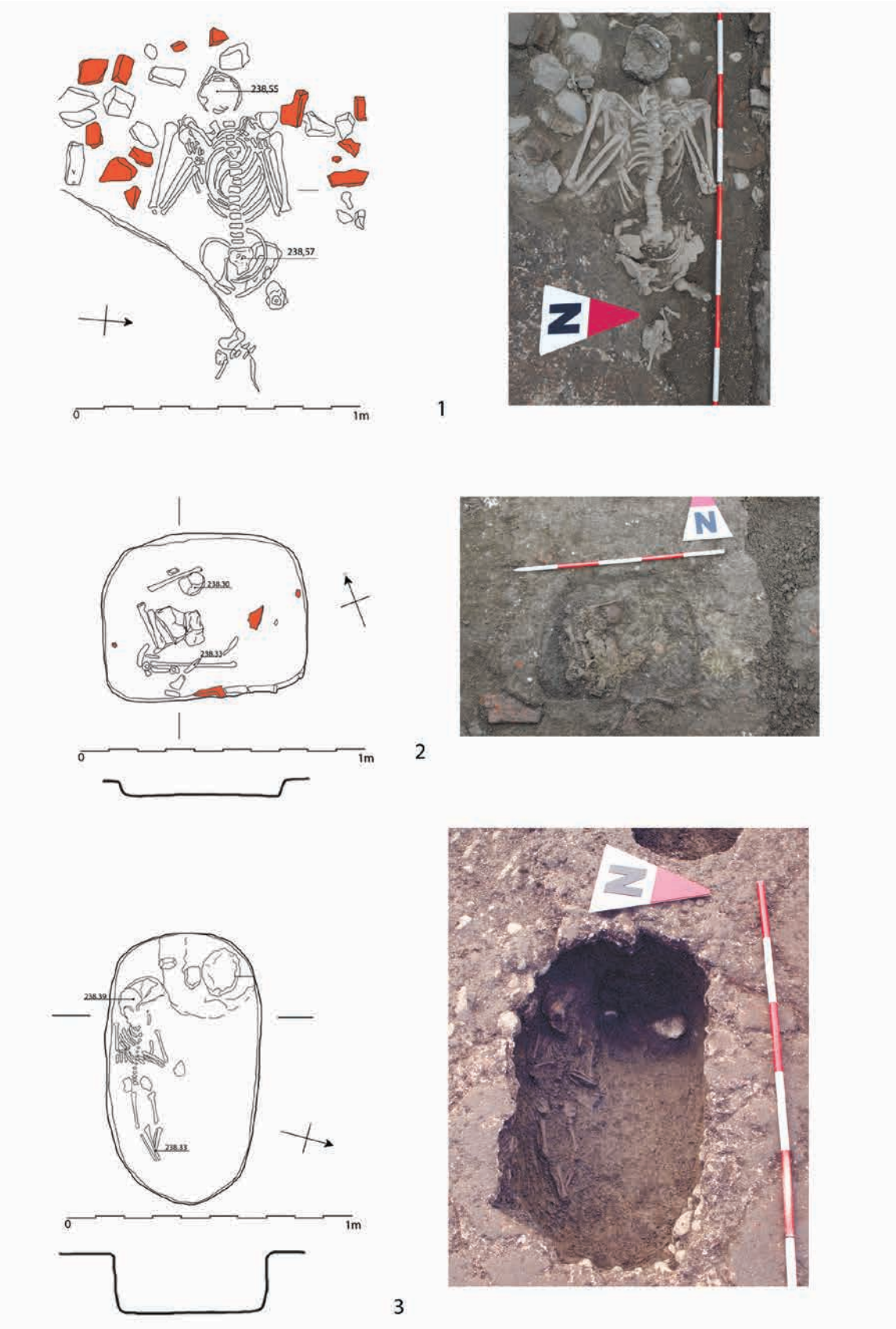

Figure 5. Graves 1 – 3 (documentation of the National Museum Čačak; drawing: Lj. Bogićević; photo: K. Dmitrović).

recognisable. The upper part of the skeleton was lying on the Late Roman rubble soil that filled the channel along the western Wall 1 in Room 1, while the pelvis and lower limbs were laid on the mortar floor (▼238.48).

The skeleton is relatively well-preserved, approximately 50-70 % of material is present. The sex is estimated as male, aged between 23 and 26 years and a body height of 163 cm. There are visible signs of caries and abrasions on the teeth. Traces of pathological conditions are identifiable on the bones of the spinal column and the attachments of the chest muscles.

Grave 2. Inhumed deceased in secondary position, re-buried probably after damaging an older grave, placed in a pit in non-anatomical order (▼238.30) (**Figure 5/2**). The pit is rectangular in shape with rounded edges, measuring 0.70 x 0.58 m, dug into the rubble soil in the northern part of the *horreum* Room 2. The skeleton is poorly preserved - incomplete, markedly fragmented and extremely robust. Based on the degree of fusion of the distal diaphysis of the tibia, femoral head and greater trochanter, the deceased was estimated as a male, 16 – 20 years old. Asymmetrical deposition of dental calculus and mild tooth attrition (grades 1-3) can be observed. Anterior cervical imprint (ACI) was registered.

Grave 3. Inhumed deceased in the primary position, oriented W – E with a deviation of 14.5° towards the south. The arms were crossed over the chest and the legs crossed below the knees (**Figure 5/3**). The burial pit is oval in shape, measuring 0.95 x 0.53m, dug through the Room 1 floor with the base in yellow clay soil (▼238.26). A relatively poorly preserved skeleton was significantly fragmented and eroded. The estimated age of 9±3 months is in accordance with the dentition and the left femur length of 11.9 cm.

Grave 4. Inhumed deceased in the primary position with arms crossed on the chest, regularly oriented W – E (**Figure 6/4**). The burial pit is roughly rectangular in shape with rounded shorter sides, measuring 1.59 x 0.40 m, cut through the floor of Room 1 in a yellow clay soil (▼238.07). A damaged, hollow, spherical bronze button with a wire loop was found on the right side of the chest.

The skeleton is relatively well preserved, with the expected level of fragmentation. Based on the dentition, the age is estimated at 12 ± 2.5 years. Calculus deposits are present on the surfaces of the lower front teeth. The orbital roofs show porosity (*Cribra orbitalia*). A thorn-shaped bone *exostosis* is present on the anteromedial part of the distal metaphysis of the left humerus (**Figure 13/1, 2**).

Based on the radiocarbon analysis of the skeletal material, the death of the deceased was determined to be between 670 and 820 calAD.

Grave 5. Inhumed deceased in the primary position with hands on the pelvis, oriented W – E with a deviation of 13.5° towards the south (**Figure 6/5**). The rectangular burial pit of dimensions 1.95 x 0.60 m was dug through the floor of Room 1, with the bottom in a yellow clay soil (▼237.92).

A well-preserved skeleton with little fragmentation and missing part of the pelvis belonged to an adult female (mature/senile stage). The height of the individual (based on length of the right femur of 45 cm) was estimated at 158.9–170.3 cm. Numerous teeth were lost *antemortem*, and the remaining show significant attrition (grade 5-7), with strongly exposed roots and abundant calculus deposits. Infectious changes in the form of numerous abscesses are present in the alveolar parts of both jaws. Bone deposition within the maxillary sinus indicates chronic sinusitis. Significant degenerative changes are present on the vertebrae, and squatting facets can be observed on the distal ends of the tibia.

Grave 6. Inhumed deceased in the primary position with arms on the chests, oriented W – E with a deviation of 8.5° towards the south (**Figure 7/6**). The burial pit was roughly rectangular in shape with rounded shorter sides, of dimensions 1.55 x 0.55m, dug through the floor of Room 1. The bottom of the grave was dug into yellow clay soil (▼237.80); some remains of wood are recognized, possibly parts of a chest or a plank.

The skeleton is relatively well preserved and complete, with the expected level of fragmentation. Based on the dentition, the skeletal remains belonged to a child 8 ± 2 years old. The length of the right femur of 29.1 cm indicates approximately 7 years of age. Large carious lesions are present at the occlusal surfaces of the deciduous molars. The crowns of the anterior permanent teeth show hypoplastic enamel defects (lines and pits). The orbital roofs show porosity (*Cribra orbitalia).*

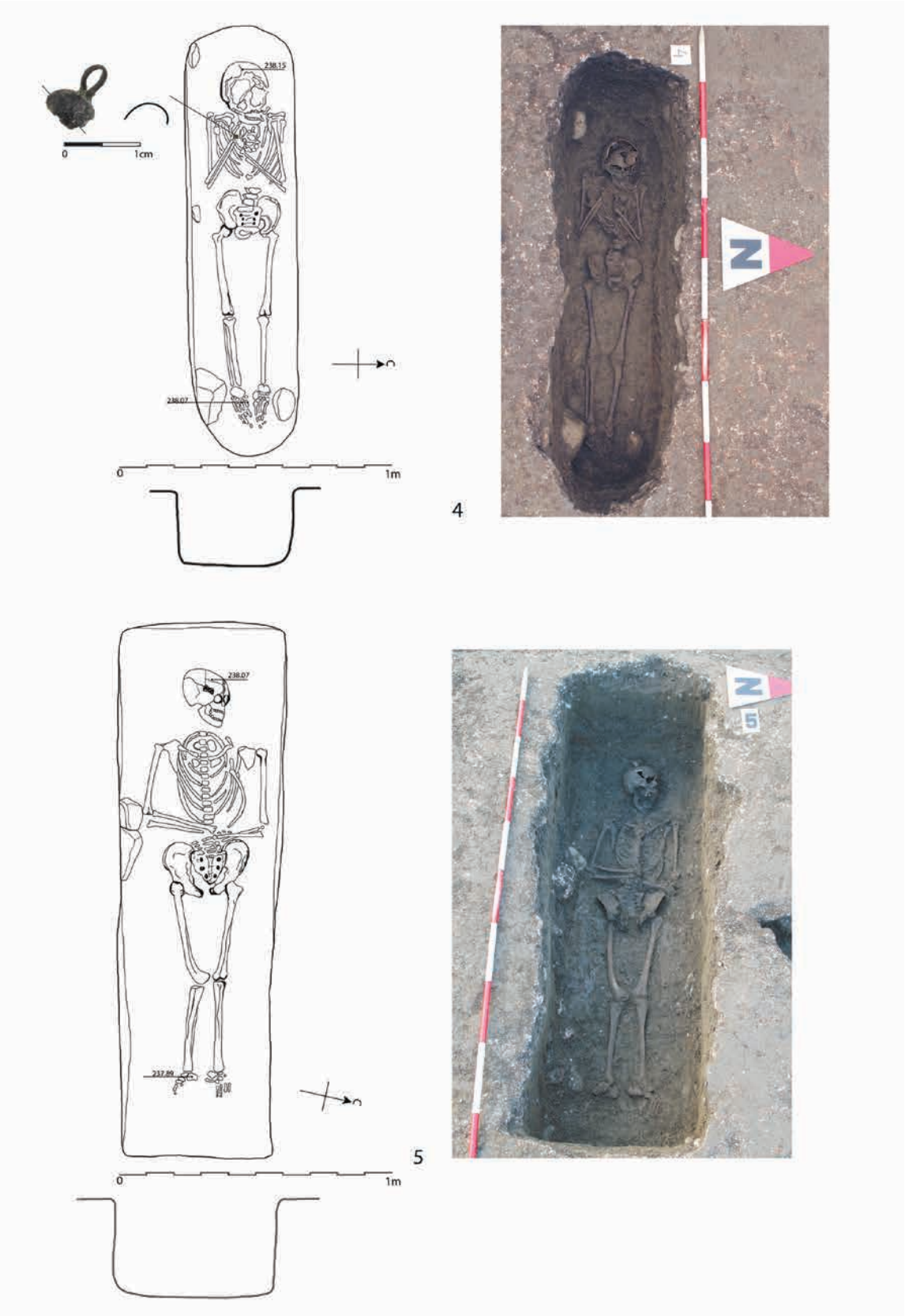

Figure 6. Graves 4 and 5 (documentation of the National Museum Čačak; drawing: Lj. Bogićević; photo: K. Dmitrović).

Grave 7. Inhumed deceased in the primary position with hands on the pelvis, oriented W – E with a deviation of 16.5° towards the south (**Figure 7/7**). The burial pit was rectangular in shape, measuring 1.98 x 0.67 m, dug through the floor of *horreum* Room 1 (▼237.80). Grave 7 cut the earlier late antique Pit 5.

The relatively well-preserved skeleton, with little fragmentation and erosion of bone surfaces, belonged to an adult female (mature adult). Both hands are missing. The body height (based on the right femur length of 42 cm) was estimated at 150.8–162.3 cm. Many teeth were lost during the lifetime, while the remaining show significant attrition (grades 4-7) and were heavily covered with dental calculus. Alveolar resorption and mandibular atrophy are present. Degenerative changes can be observed in the bodies of the cervical vertebrae, and the thoracic vertebrae show a slightly asymmetrical shape.

Grave 8. Inhumed deceased in the primary position with the right hand crossed over the left forearm on the pelvis, oriented W – E with a deviation of 6° towards the south **(Figure 8/8**). The burial pit was rectangularly shaped, measuring 1.95 x 0.58 m, dug through the mortar floor of Room 1, with the bottom in yellow clay soil (▼237.81).

The well-preserved skeleton with minimal fragmentation and bone erosion belonged to an adult male individual. The body height (based on the right femur length of 47.5 cm) was estimated at 165.8–178.3 cm. *Antemortem* tooth loss and significant deposits of calculus and attrition (grades 2-5) can be observed. Mild osteoarthritic changes on the knee joint, and on the left foot bones are noted. There is a slight deviation of the nasal septum. A large foramen - a congenital malformation – can be observed on the sternum (**Figure 13/3**).

A heavily corroded iron object in the shape of a bent rod ending with two knob-like thickenings was found under the deceased's feet.

Grave 9. Inhumed deceased in the primary position, oriented W – E with a deviation of 6° towards the south. Placed in an irregularly shaped pit, measuring 0.55 x 0.40 m, with an extension cut in the south from Grave 8 (▼238.30) (**Figure 8/9**).

A very poorly preserved skeleton of a foetus or an infant, incomplete and fragmented, without pronounced erosion of the bone surfaces. Parts of the neurocranium and several fragments of postcranial bones are preserved. Based on the femur length of 6.83 cm, a developmental stage of 34-40 gestational weeks was estimated.

Grave 10. Inhumed deceased in secondary position, disturbed by the later Grave 11 (**Figure 8/10**). Consequently, the older skeleton was secondarily placed along the southern, western and northern edges of Grave 11. Grave 10 was irregularly rectangular in shape. The southern side is damaged, with dimensions of 2.1 x 0.50 m, cutting through the Room 1 floor, oriented W – E, with a deviation of 15.5° towards the south (▼ 237.99). A zone of red-baked earth was along the western grave edge.

The skeleton is quite fragmented, the bone surfaces are eroded and many bones are missing. The deceased was estimated as an adult male. On the basis of the left femur length of 45.6 cm, the height estimation is 160.6–173.2 cm. Poor oral health with multiple teeth lost during the lifetime, a high degree of attrition (grade 5-7) and alveolar resorption and abscesses are noted. The bodies of the right fibula and tibia indicate a chronic inflammatory process – osteomyelitis. Thickenings and drainage openings on both bones are also visible (**Figure 13/4**). The locations of the major changes (lower third of the diaphysis) indicate that trauma was the possible cause of infection. On the left tibia, squatting facets can be observed.

Grave 11. Inhumed deceased in the primary position with hands on the pelvis, oriented W – E with a deviation of 15.5° towards the south (**Figure 8/11**). The burial pit was irregularly shaped, measuring 2.30 x 0.75 m, disturbing the older Grave 10 (▼237.83).

A well-preserved skeleton with minimal fragmentation and erosion of bone surfaces was estimated as an adult female. All the teeth, with calculus deposits and no particular attrition, are present. No traces of palaeopathological changes can be observed. The body height of the individual, based on the right femur length of 43.4 cm, was estimated at 154.6–166 cm.

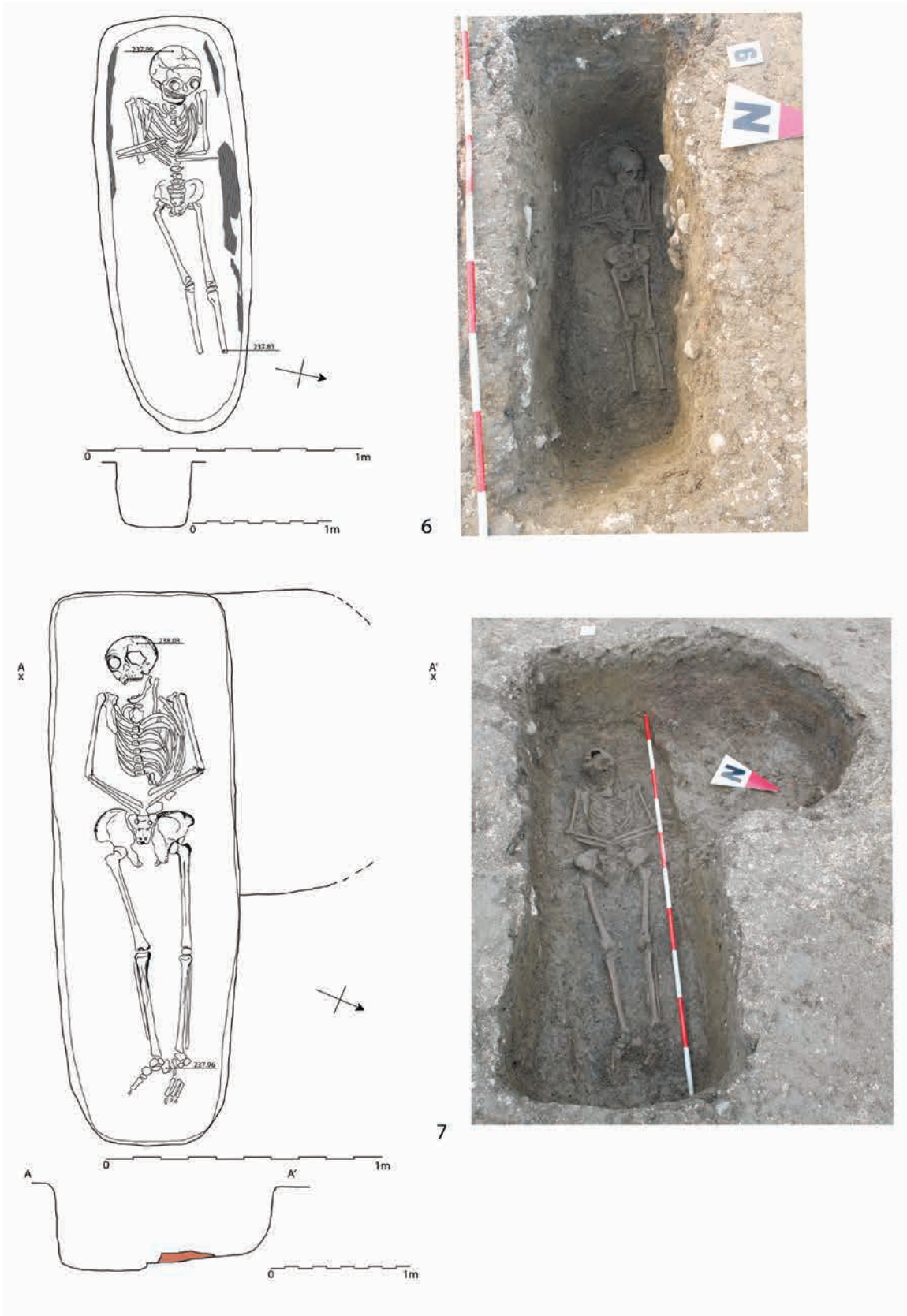

Figure 7. Graves 6 and 7 (documentation of the National Museum Čačak; drawing: Lj. Bogićević; photo: K. Dmitrović).

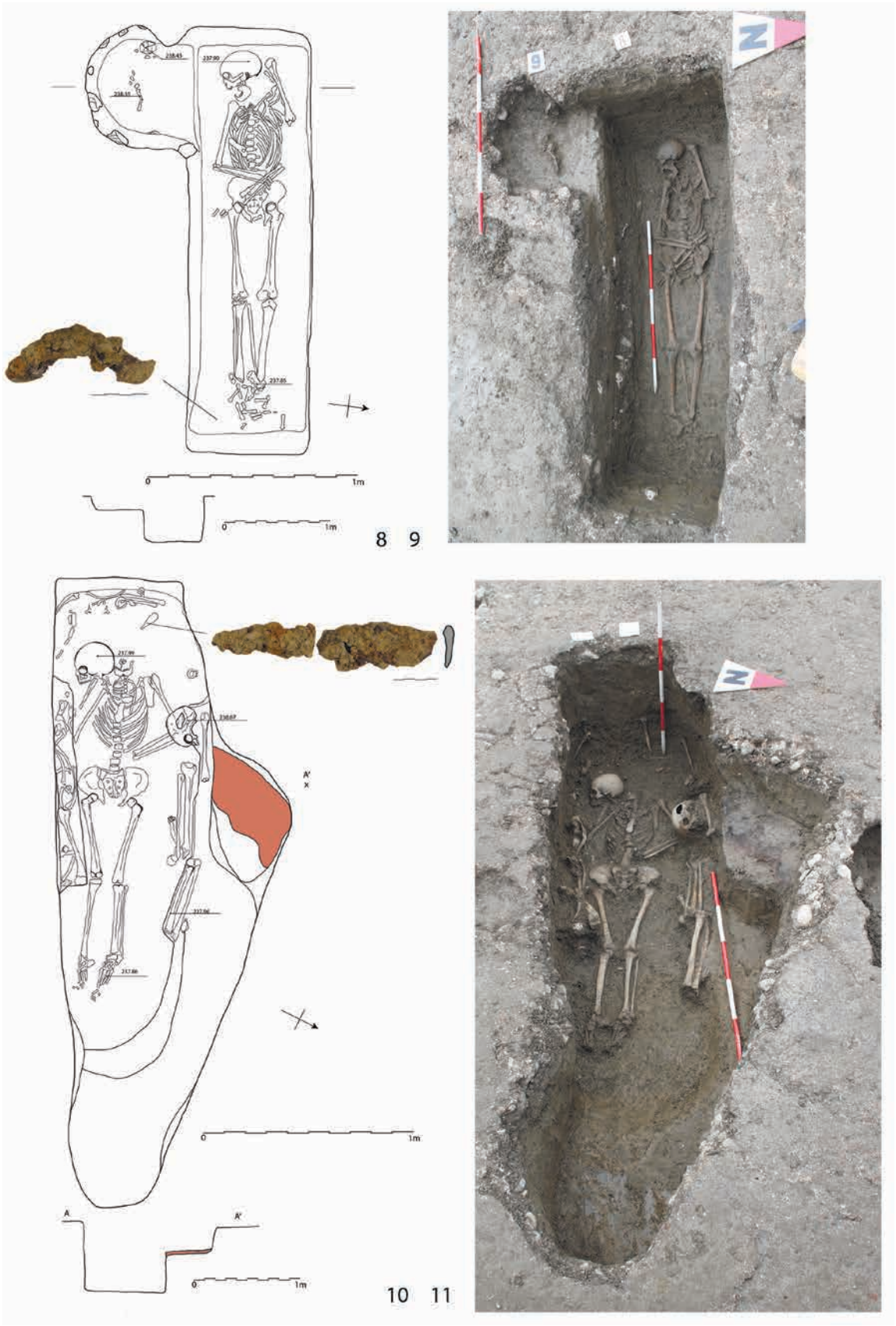

Figure 8. Graves 8 – 11 (documentation of the National Museum Čačak; drawing Lj. Bogićević; photo: K. Dmitrović).

An iron blade found northwest of the head most probably belonged to the late antique soil, which partially filled the pit.

Grave 12. Inhumed deceased in the primary position with the hands on the pelvis, oriented W – E with a deviation of 24.5° towards the south (**Figure 9/12**). Placed in a rectangular pit, measuring 1.95 x 0.50 m, dug through the Room 1 floor into the yellow clay soil (▼237.83).

The skeleton is relatively complete, but fragmented and eroded, and estimated as an adult female (mature/senile). The oral health was extremely poor. Most of the teeth were lost during the lifetime. Degenerative changes in the vertebrae indicate *scoliosis*, and in the limb joints there are traces of *osteoarthritis*. The body height, based on the right femur length of 44.4 cm, was estimated at 157.2 – 168.2 cm. The distal edges of the tibia show the presence of squatting facets.

Grave 13. Inhumed deceased in the primary position with the hands on the pelvis, oriented W – E with a deviation of 6.5° towards the south (**Figure 9/13**). The burial pit was oval in shape, with dimensions of 1.10 x 0.55 m, and dug through the Room 1 floor (▼238.09). The grave pit extended to Wall 3 but did not damage it.

The skeleton is relatively well preserved, with the expected level of fragmentation, and without erosion of the bone surfaces. Based on the dentition development, the deceased was 24 ± 8 months old. The length of the left femur of 15 cm indicates an age of approximately 1.5 years. There were no registered palaeopathological changes.

Grave 14. Inhumed deceased in the primary position with the right hand on the chest and the left on the pelvis, oriented W – E with a deviation of 8.5° towards the south (**Figure 10/14**). The deceased was placed in an irregularly rectangular pit with rounded corners, measuring 1.10 x 0.45 m, dug through the Room 1 floor into the yellow clay soil (▼238.01).

The skeleton is well-preserved and complete, with the expected level of fragmentation, and without significant erosion of the bone surfaces. Based on the dentition development, the deceased was 18 ± 6 months old. The right femur length of 14.17 cm indicates that the individual was approximately 12 months of age. The green stains on the right collarbone indicate contact with a copper or bronze object.

Radiocarbon analyses of a human bone sample determined the time of death between 1420 and 1450 calAD.

Grave 15. A damaged grave with at least two skeletons in non-anatomic order (▼237.88) placed in a pit dug through the *horreum* Room 1 floor, and disturbed by Grave 16 (**Figure 10/15, 16**). It is assumed that the dimensions of the younger Grave 16 are somewhat similar to the older pit, and that the extension on the southern side belonged to a child's grave. The human skeletal material found around Grave 16 at different levels and in different positions belonged to an older female and a child. The skeletal material of both individuals is partially preserved.

Grave 16. Inhumed deceased in the primary position with the hands on the pelvis, oriented W – E with a deviation of 13° towards the south (**Figure 10/16**). The deceased was placed in a pit roughly rectangular in shape, measuring 2.15 x 0.65 m, disturbing the older Grave 15 (▼237.68).

The well-preserved skeleton with all anatomical regions, with moderately eroded surfaces and little fragmentation belonged to a mature adult female. The body height (based on the right femur length of 42.1 cm) was estimated at 151.1–162.5 cm. A large number of teeth was lost during the lifetime, and the remaining show a high degree of attrition (grade 5-7), caries and calculus. Degenerative changes of the lower jaw, a large abscess and pronounced alveolar resorption are noticeable. The vertebrae also have degenerative changes (*spondylosis* and *spondylarthrosis*), and the *foramen magnum* and some vertebrae are strikingly asymmetrical. At the skull base, stenosis of the left carotid canal and asymmetry of the jugular foramen size can be observed (**Figure 13/5**).

Grave 17. Inhumed deceased in the primary position with the arms placed alongside the body, oriented W – E with a deviation of 13° towards the south (**Figure 11/17**). The deceased was laid in a roughly rectangular pit, of dimensions 0.70 x 0.30 m, dug along the southern side of Grave 18 (▼238.32).

A well-preserved skeleton with the expected level of fragmentation missed the maxilla with the teeth and the left femur. Based on the mandible, and the left tibia length of 89 mm the deceased

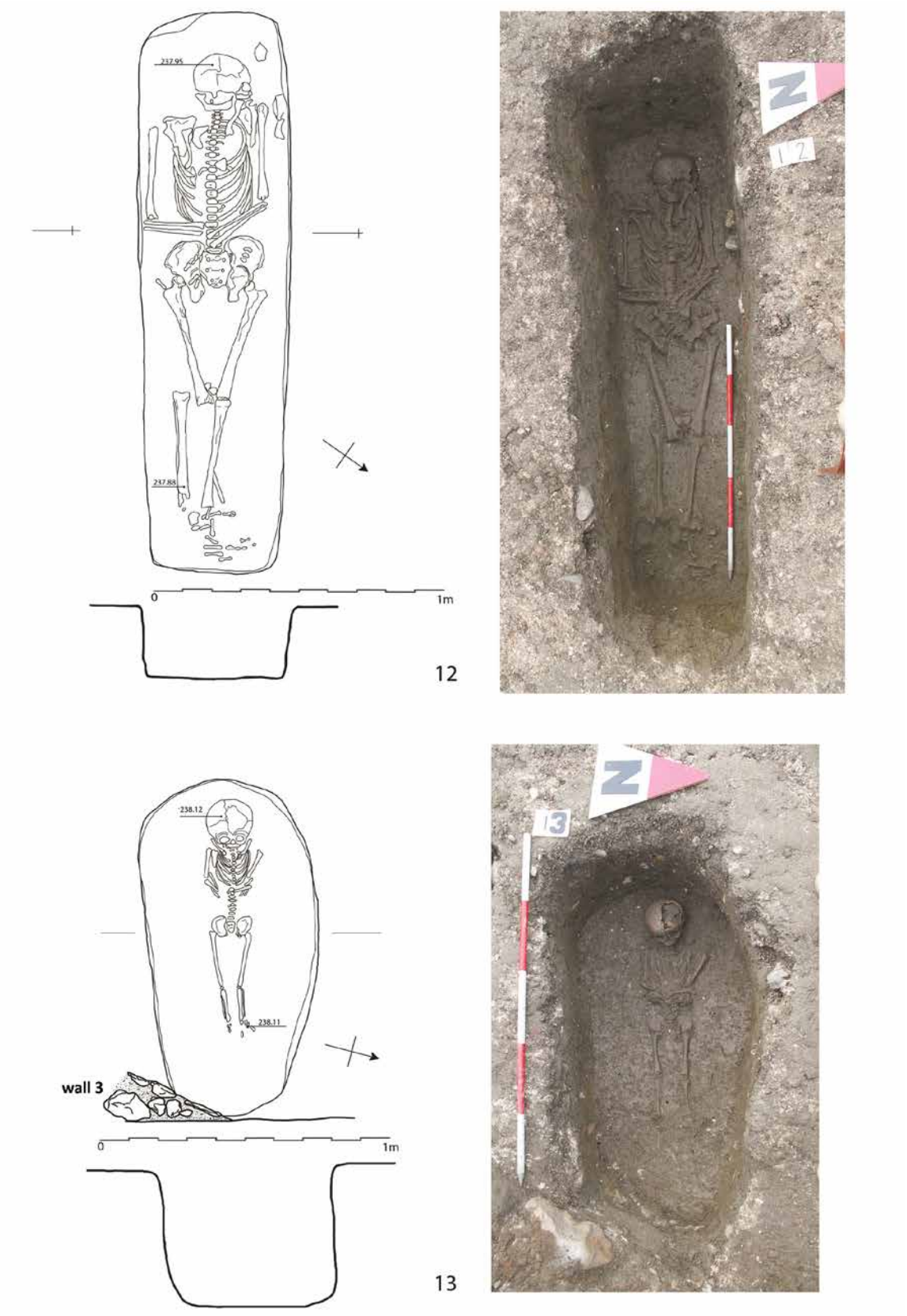

Figure 9. Graves 12 and 13 (documentation of the National Museum Čačak; drawing: Lj. Bogićević; photo: K. Dmitrović).

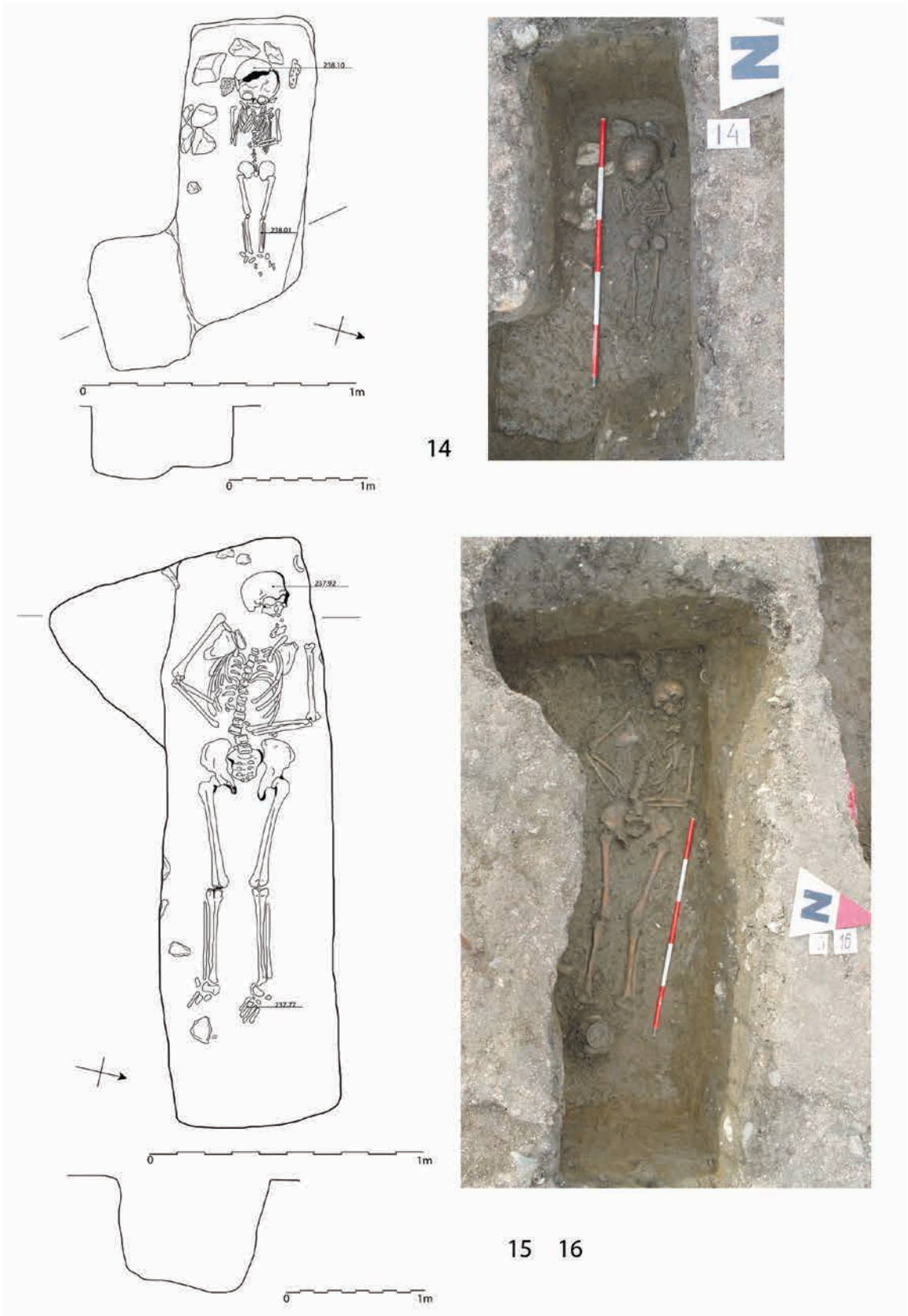

Figure 10. Graves 14 – 16 (documentation of the National Museum Čačak; drawing: Lj. Bogićević; photo: K. Dmitrović).

was estimated as an infant of approximately 3 months old.

Grave 18. Inhumed deceased in the primary position with the left arm stretched along the body and the right slightly bent and the hand under the pelvis, oriented W – E with a deviation of 15.5° towards the south (**Figure 11/18**). The pit was irregularly rectangular in shape, measuring 1.87 x 0.65 m, dug through the Room 1 floor (▼237. 98). The lower limbs of deceased were located below the edge of a trench in 2014, which was later completed and it was subsequently determined that the grave pit extended to Wall 3, but did not damage it.

The well-preserved and complete skeleton belonged to an adult female. The erosion of the bone surfaces is minimal, but the cranium is distinctly fragmented. The body height, on the basis to the right femur length of 40.3 cm, was estimated at 146.2–157.6 cm. Several teeth were lost during the lifetime, and advanced alveolar resorption and attrition are evident.

Grave 19. The partially excavated Grave 19 consisted of a skeleton in the primary position with the arms on the chest, oriented W – E with a deviation 4.5° to the south (**Figure 11/19**). The lower limbs remained below the eastern edge of the archaeological trench and, therefore, the grave was left *in situ* and was not anthropologically analysed. Based on the dimensions of the skeleton, it is assumed that it was an older child or an adolescent. Grave 19 is the only one explored outside the late antique *horreum*, on its southern side, buried in a layer of light brown soil (▼237.80). The edges of the grave pit were not clearly recognizable.

* * *

The described graves show considerable similarity in terms of burial rituals, but certain details allow some variations. Based on the deviation from the W-E axis towards the south, it seems that three groups can be distinguished. The first group with the correct W-E axis includes Grave 4 and the damaged Grave 10. The second group, whose deviation towards the south is between 6 and 15 degrees, includes Graves 1, 3, 5, 6, 7, 8, 9, 11, and 13–19. The third group consists of graves with the largest deviation of about 25 degrees and includes Grave 12 and the defined but, as yet, unexplored graves in its immediate vicinity (**Figure 2**).

The deceased were placed in rectangular pits with rounded corners, less often in oval ones, arranged in rows, cut through a late antique brown soil with rubble, and the floor and walls of the *horreum* (**Figures 4 and 12**). The bottom was in a sterile, yellow clay soil, most often between ▼237.7 - 238.0 m. It is noted that the graves of children are located at a somewhat shallower position, usually around ▼238.3 m. The graves were without any specific burial structures, except for the wood remains under the deceased in Grave 6, which may indicate that the deceased was placed on a wooden base. Overlaps were noted in two cases; Grave 10 from the first group was damaged by Grave 11. The double Grave 15, in which a female individual and a child were buried, was damaged by Grave 16.

Unlike Grave 19, which was outside the *horreum*, all the other grave pits dug through the hydraulic mortar floor of the Room 1 were clearly visible (▼238.52 – 238.55). Their dimensions were in accordance with the age of the deceased. The adult individuals were laid in graves measuring 1.90-2.15 x 0.5-0.7 m, adolescents around 1.6 x 0.5 m, and children 0.55-1.5 x 0.3-0.55 m. The pits were filled with earth comprising yellow clay and brown soil with rubble. Based on their shape, dimensions and orientation, it is assumed that there were at least seven more graves, all of which remain unexplored. They penetrated the *horreum* Wall 2 and Wall 3, and their position indicates that the cemetery extended further to the east (**Figure 2**).

Human osteological analysis determined four individuals as males, seven as females, while nine individuals of child age had no determined sex (conditionally including Grave 19 in this group). The position of the arms does not allow a clearer regularity. A total of eight individuals had their arms crossed over the pelvis – four females, one male and three children, and the arms positioned over the chest was noted in four cases – one male, two children and one adolescent. Different positions – both arms along the body or one along the body with the other bent at the elbow, and hand under the pelvis (Graves 17 and 18) – represent isolated cases, registered only in the double grave

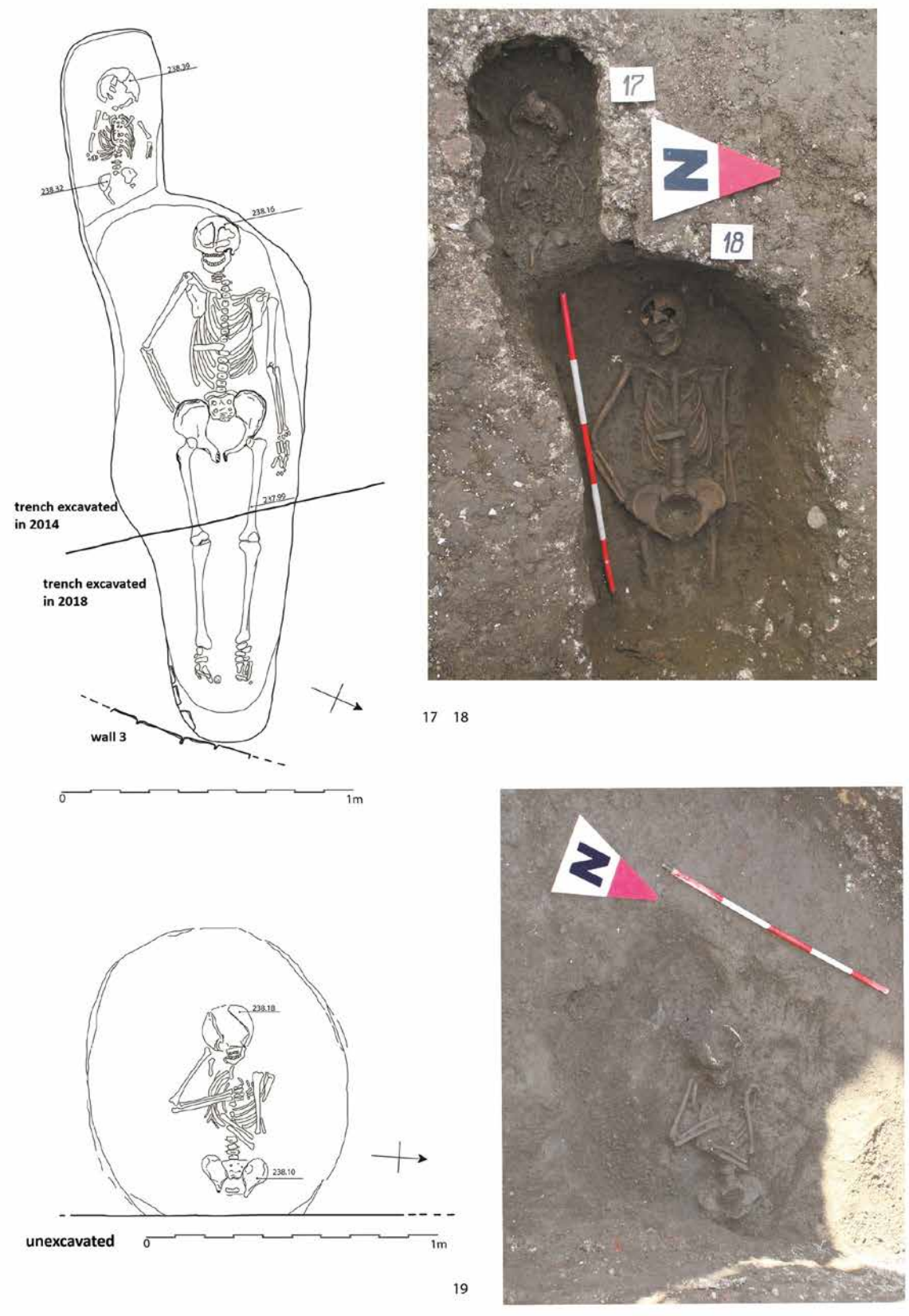

Figure 11. Graves 17 – 19 (documentation of the National Museum Čačak; drawing: Lj. Bogićević; photo: K. Dmitrović).

Figure 12. Cross-section above Graves 18 and 13 (documentation of the National Museum Čačak; photo: K. Dmitrović).

with an adult female individual and a child of three months of age.

In three cases, burials of adults with children were identified – Graves 8 and 9 (a male and a child), Graves 17 and 18 (a female and a child), and in the damaged Grave 15 (a female and a child). In all three examples, the graves with the children's skeletons were buried along the SW side of the grave pit with the adult individual. A similar example was noted in the medieval Grave 17 at the cemetery *Thermae* in Čačak, where a child was buried directly above an adult individual (Радичевић 2001: 27).

More than a half of burials belonged to children and younger individuals. All female and two male deceased were buried at the age of mature or older adults. Dental health was very poor; nine adult individuals had caries, alveolar abscess, and teeth were often lost during the lifetime. Most authors associate these diseases with a diet rich in carbohydrates and poor in proteins (Lukačević and Šlaus 2016: 143–144). Enamel defects defined in Grave 6 are often associated with starvation, vitamin A, C, or D deficiency, anaemia, or psychological/physical stress (Vyroubal, Pleše and Novak 2016: 92–94). The presence of *cribra orbitalia*, or porosity of the orbital roofs, registered in Graves 4 and 6, in the broadest sense also indicates poor nutrition and poor health. According to some authors, it is an indicator of anaemia caused by iron deficiency, parasitic infections, scurvy and other reasons (Šarkić and Branković 2020: 165; Ђукић *et al.* 2021: 69, 72; Vulović 2024: 286). The squatting facets from Graves 5, 10 and 12 arise as damage to the joints due to frequent activities requiring a squatting position, as a result of cultural reasons, a lack of furniture or performing various household activities (Šarkić and Branković 2020: 165).

The graves were without grave finds.[3] Grave 4 stands out, with a damaged button that was a functional part of the clothing, from which the upper calotte made of bronze sheet with a loop for fastening was preserved (**Figure 6/4**). Similar buttons are usually dated broadly from the 10th

[3] The iron object in the form of a handle from Grave 8 and the iron blade from Grave 11 can be conditionally considered as the grave inventory, since they could have been included in the grave fill from the older late antique soil.

Figure 13. Selection of determined pathologies: 1, 2 – Grave 4; 3 – Grave 8; 4 – Grave 10; 5 – Grave 16 (documentation of the National Museum Čačak; photo: P. Radović).

to the 15th century (Фидановски 2010: 46), but there is a possibility that a button from Gradina on Jelica is slightly older (Милинковић 2017: 233, кат. 506). Analogous buttons from the Ravna cemetery have been dated to the 9th and 10th century (Jovanović and Vuksan 2005: 219, 240). According to V. Bikić, the earliest buttons appear in the 12th – 13th century. Their occasional occurrence in graves indicates that they were used to fasten a simple shirt or dress with a slit for the head (Бикић 2010: 114). Very similar buttons with a granule on the bottom originate from the nearby cemeteries in Mrčajevci and Trnava, and are dated to the 15th and 16th century (Радичевић 2000: 103).

No grave markers made of durable material were discovered. It is possible that other designations may have existed, as overlapping of graves from the same phase was rarely observed, rather they were relatively regular arranged in rows. Radiocarbon analysis of human osteological material from Graves 4 and 14 yielded two dates, which may be of preliminary help for chronological considerations.

DISCUSSION AND CONCLUSIONS

The discovered graves at the Gimnazija High School Courtyard site represent the north-western part of a Christian cemetery that extended to the edge of the plateau above the former West Morava riverbed. The graves were dug through the *horreum* Room 1 floor and walls, causing severe damage, which could lead to the presumption that most of this late antique building was no longer visible at that time. Its peripheral position regarding the church on the one side and the river course on the other, could have been instrumental in establishing the burial place. On the other hand, the cemetery foundation around or within the older structures, even the prehistoric tumuli, represents a well-documented practice during the Middle Ages (Веселичић 2008). The beliefs and ritual norms, according to which the eternal rest of the late community members was set within the earlier structures, speaks in favour of the long-term maintenance and continuity of the sacred spaces and the ancestral world (Diaz-Guardanime, Garcia-Sanjuan and Wheatley 2015). Besides the examples from Čačak, medieval burials similarly dug into Roman structures are known from many sites, such as Ravna, Gamzigrad, Sirmium and others (Jovanović and Vuksan 2005; Јанковић 1983: 144–146; Petković 2011: 276–279).

The dating of the cemetery at the Gimnazija High School Courtyard site is somewhat challenging and the absence of grave inventory additionally complicates the task. To a certain extent, the presented radiocarbon dates could be helpful, but could also lead to a degree of doubt. This mainly concerns the AMS C14 date from Grave 4, which points to 670 – 820 calAD. Such early dates for graves in the Central Balkans are almost unknown and the majority of cemeteries organized in rows with a Christian burial ritual are dated to the 9/10th – 11th century (Шпехар 2017: 104–106, Сл. 15). Earlier dates are without confirmed graves so far, although the possibility of their existence is based on the assumption of the survival of certain groups of the Romaic population after the collapse of Byzantium in this territory in the 7th century (Шпехар 2017: 106–108).

If we accept the given radiocarbon dating of Grave 4 and take into account the orientation Grave 10, this rather refers to the latest date within the specified range. To a certain extent, the dating to the 9th century could be supported by the latest C14 dates from the charred wood found on the outer side of the southern rampart of the Roman fortification excavated in 2022 and 2024 in the museum courtyard. Recent results have indicated that the Roman fortification was most likely repaired and strengthened using some wooden structure, dated by radiocarbon analyses to between 897 and 1022 calAD (Дмитровић и Ћирковић 2024: 228). This date was recently confirmed by another AMS C14 analysis of wood remains taken from a trench researched in 2024, in the continuation of the southern rampart.[4] Reuse and reparation of older fortifications and the formation of medieval proto-urban centres represent a practice widely noted during the 9th century, reflecting the changes to the Slavic settling models caused by political circumstances (Шпехар 2017: 54, 70, 95–98, Сл.1; Булић 2022).

[4] According to the researchers of the National Museum in Čačak. A research report with details of the excavation in 2024 is in preparation.

Construction activities undertaken from the 9th to 10th century on the Roman fortification in Čačak indicate the existence of a settlement even before the foundation of the Prince Stracimir endowment by the end of 12th century, which was, by then, widely known as Morava Gradac (Калић 1993; Радичевић 2003: 236–238; Радисављевић, Булић и Војновић 2025).

Albeit logical and supported by facts, the proposed dates of Graves 4 and possibly 10 are not altogether convincing. These graves were not isolated from the other graves and were incorporated into the row system of burials. Additionally, they had quite similar grave pits cut through the mortar floor of the *horreum*. The only grave find, a damaged bronze button from Grave 4, does not provide much help. Similar buttons are broadly dated from the 9th to the 15th century, although parallels from nearby Mrčajevci and Trnava indicate the late medieval period (Радичевић 2000: 103) Also, one can assume the possible sample contamination that could have given an incorrect date. Overall, in addition to the listed arguments, certain doubts are raised by the different deviation of Graves 4 and 10 compared to most of the others, as well as the disturbance of Grave 10 by a later burial. It seems that a more precise answer to the accurate dating of these burials can be provided only by future additional and more focused analysis. The available C14 dates can be considered just as a starting point for further, more specific and intensive research, which could enable a reliable basis for a more precise chronological determination.

The largest number of graves belong to the late Middle Ages. This determination is additionally confirmed by an AMS C14 date from Grave 14 (1420 – 1450 calAD), which belonged to a larger group with the declination towards the south. This dating could be supported with two dates recently obtained from the graves excavated at the museum courtyard. In the area around the western rampart of the antique fortification, about 100 m southwest of the church, five graves were discovered. These freely buried individuals, in a supine position without any finds and oriented W – E, were also dated to the first half of the 15th century by radiocarbon analyses.[5] Bearing this in mind, it is very likely that the given results can provide a more reliable basis for defining the late medieval burial practice characterised by the almost total absence of any grave finds, although this type is present during both earlier and later centuries.

Besides the mentioned graves, in the immediate vicinity of the Gimnazija High School, a few other medieval cemeteries and graves have been explored. A larger cemetery also existed in the city centre, around the medieval church, whose foundations are beneath the modern city church of the Ascension of the Lord (Чанак-Медић 1993) (**Figure 1/1,2**). This group would include the medieval graves excavated in the church portico[6] (Вукадин 1993: 100–101), those from the nearby northern part of the museum courtyard (Бабић и Јеремић 2006: 49–52) and along the eastern rampart of the fortification, discovered next to the main entrance to the Gimnazija High School (Vujadinović and Bogićević 2024: 130). Another cemetery at the site of 44 Bate Jankovića Street[7], about 120 m to the northwest of the Gimnazija High School's courtyard was recently partially explored (**Figure 1/7**).

A cemetery dug into the late antique baths (*thermae*) was dated to the 11th/13th century (Радичевић 2001: 35; Радичевић 2003: 238) (**Figure 1/5**). It is very likely that this cemetery was much larger, as evidenced by graves damaged during the construction work for the new post office, approximately 50 m to the southwest of the *thermae* (Радичевић 2001: 24; with note 3). Since 2023, archaeological research has been taking place on the western side of the baths (at

[5] The human osteological material was dated using the AMS 14C method at the Isotoptech laboratory in Debrecen, Hungary. A more detailed publication on the results of the excavation of the Čačak Museum courtyard in 2024 is in preparation, according to the researchers of the National Museum in Čačak.

[6] During research between 1999-2002, organized by the Institute for the Protection of Cultural Monuments in Kraljevo, a large number of graves was discovered. The results have not yet been published.

[7] A rescue archaeological excavation organized by the National Museum in Čačak at the site of No. 44 Bate Jankovića Street was carried out in 2023. The results have not yet been published; only preliminary information has been obtained from the short reports (Рајић 2024: 181–182).

the site of 24A Gradsko šetalište)[8], resulting in the discovery of a large number of medieval graves in a relatively restricted area.

The positions and dating of the mentioned cemeteries in the city centre raise many questions regarding their connection to the medieval settlements that existed throughout the centuries at some point in the surroundings. The already considerable total number of graves may indicate a relatively intensive settling at this favourable location, on the remains of a Roman fortification and a settlement, representing an important hub within the communication network, a practice that was widely practiced during the Middle Ages (Benevolo 2004: 29–42). Besides the modest remains of a settlement dated to the 10th – 12th centuries discovered in the church portico (Вукадин 1993: 100–103; Радичевић 2003: 238), recently intensified archaeological excavation within the centre of modern Čačak did not provide further information on this issue. Some indications of medieval structures are possible at the museum courtyard, but it seems that the medieval layers were mostly levelled during the construction of the Austrian fort in the 18th century (Дмитровић и Ћирковић 2024: 228–229; Дмитровић и Ћирковић 2025). In addition, the dense infrastructure in the central part of the modern city makes research more difficult and limited.

The deceased buried in the cemetery discovered at the Gimnazija High School Courtyard site were most likely residents of a nearby settlement in the second half of the 14th and the beginning of the 15th century, but the restricted extent of excavations cannot provide a basis for discussion regarding the size and character of the habitation in which they lived. During this period, the large devastation of the Serbian medieval state carried out by the Hungarians and Ottomans was recorded. Nevertheless, it also represents a period of prosperity during the age of Serbia's despots, with notable progress in agriculture, and especially in mining and trade activities, which attracted a large number of merchants and artisans from Dubrovnik, who lived alongside the Serbian population. Traders from Dubrovnik inhabiting Čačak were also documented at the beginning of the 15th century, which is the exact date when the present-day name of the city appeared, while Gradac was by then preserved in the name of the church dedicated to Virgin Mary of Gradac. The settlement included a caravan station, but also an ecclesiastical and administrative centre, situated by the road that connected the most important mining centre in medieval Serbia - Mount Rudnik, with the road to Dubrovnik, enabling its rapid and significant development (Веселиновић 1993: 68–71).

The political and social climate, as well as the general circumstances typical for life in medieval Serbia (Марјановић-Душанић и Поповић 2004; Јелић и Радић 2015), also influenced the daily life of medieval Čačak's inhabitants. Palaeopathological changes defined on the discovered skeletons speak of inadequate hygiene and health conditions, poor or particular nutritional habits and physically demanding jobs, all of which indicate a cluster that lived in more difficult circumstances. A high mortality rate of children and young individuals was common (Lewis 2007; Миладиновић-Радмиловић 2008), and childbirth and the time immediately after was particularly demanding and often had fatal consequences (Park 2018). A burial of a new-born with an adult man (Graves 8 and 9) illustrate the close relationship of the community in difficult moments after a new-born's death and his burial alongside a family member, possibly the father or a close relative. Similar examples may be found with Graves 15 and 16, and 17 and 18, where a young child and an infant could have been buried with their biological mothers or some other late member of the close family. Furthermore, just a few overlapping graves suggests that this cemetery was mainly used during a limited time by a smaller, perhaps kindred, community, whose relationship could be determined by further DNA analyses.

The presented analysis of the graves from the Gimnazija High School Courtyard site is a valuable contribution to the understanding of the Middle Ages in Čačak. Along with other cemeteries discovered in the close vicinity, it draws attention to the existence of significant, long-lasting

[8] The rescue archaeological excavations at the site of 24A Gradsko šetalište have not yet been published in detail; basic results have been obtained from the brief reports (Рајић 2024: 182–183; Рајић 2025: 191–192).

settlements, so far relatively insufficiently researched. A detailed publication of the existing material and more focused excavations and analyses in the future can provide a significantly clearer insight into the medieval period in such an important centre as Čačak was at that time.

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REZIME

SREDNJOVEKOVNA NEKROPOLA NA LOKALITETU DVORIŠTE GIMNAZIJE U ČAČKU

KLJUČNE REČI: ČAČAK, DVORIŠTE GIMNAZIJE, SREDNJOVEKOVNA NEKROPOLA, C14 DATUMI

Lokalitet Dvorište Gimnazije u Čačku nalazi se u centru savremenog grada, istočno od školske zgrade, između Mutapove i Lomine ulice. Pozicioniran je na rubu rečne terase duž nekadašnjeg toka Zapadne Morave, oko 150 m istočno u odnosu na centralni gradski plato, kojim dominira masivna crkva sa portom iz 19. veka. Opšte je prihvaćena činjenica da je savremena crkva sagrađena na temeljima Bogorodice Gradačke, Stracimirove zadužbine s kraja 12. veka, koja je bila značajan crkveni, administrativni i ekonomski centar u srednjovekovnoj Srbiji između 12. i 15. veka. Nedavno je otkriveno da je crkva zapravo sazidana u okvirima antičkog kastruma iz 3. veka, što je potvrdilo pretpostavke o postojanju starijeg utvrđenja po kojem je srednjovekovno središte nosilo naziv Gradac. Bogati antički i kasnoantički slojevi i celine, datovani između 1. i 5. veka, upućuju na dugotrajnost naseljavanja ove povoljne pozicije zaštićene od poplava, na raskršću važnih putnih pravaca i uz prelaz preko Zapadne Morave.

Uz gimnaziju su od 2014. do 2018. godine obavljena zaštitna arheološka istraživanja, u okviru kojih je istražena osnova horeuma, deo srednjovekovne nekropole i celine iz novijeg doba. Cilj i ograničenja iskopavanja onemogućili su istraživanje svih otkrivenih površina u potpunosti. Kasnoantički horeum dimenzija 21,2 x 10,6 m sastojao se od dve prostorije. Veća je imala vrlo kvalitetan pod od hidrauličnog maltera, dok manja sa južne strane nije imala sačuvanu podnicu. Sekundarna upotreba horeuma dogodila se krajem 4. i u prvoj polovini 5. veka, kada je ukopano više jama, od kojih su one manjih dimenzija najverovatnije predstavljale baze stubova dozidanih objekata od lakog materijala. Nakon dužeg napuštanja, ovaj prostor se ponovo koristi u srednjem veku za sahranjivanje, a tokom osmanske okupacije i novijeg doba u stambene i ekonomske svrhe.

Istražen deo srednjovekovne nekropole činilo je 19 grobova sa 20 pokojnika sahranjenih prema hrišćanskom obredu. Prema položaju grobova definisanih samo na osnovi, zapaža se da se nekropola širi dalje ka istoku ispod savremenih objekata duž Lomine ulice. Osim groba broj 19 svi ostali su ukopani unutar horeuma, kroz kasnoantički sloj mrke zemlje sa šutom i pod od hidrauličnog maltera. Inhumirani pokojnici su polagani na leđa u opruženom stavu obično sa rukama prekrštenim na karlici ili grudima,

približne orijentacije zapad–istok, sa glavama na zapadu. Polagani su u pravougaone, ređe ovalne rake zaobljenih uglova, postavljene u redovima. Grobovi su slobodno ukopavani, bez određenih grobnih konstrukcija, mada ostaci drvene podloge ispod skeleta u grobu 6 ukazuju na određene forme prilikom polaganja pokojnika. Preklapanja su zapažena u dva slučaja – grobovi 10 i 11 i dvojni grob 15 i 16. Humani skeletni materijal je preliminarno antropološki analiziran i određeni su pol, starost i patološke promene koje su protumačene kao posledica loše higijene, ishrane i težih životnih uslova kojima je bila izložena zajednica sahranjena na ovom groblju.

Prema devijaciji od ose zapad–istok prema jugu, čini se da se mogu izdvojiti tri grupe grobova. Prvoj grupi, sa minimalnim odstupanjem od ose zapad–istok pripadaju grobovi 4 i oštećen grob 10. Drugoj grupi, čije je odstupanje prema jugu iznosilo između 6 i 15 stepeni, ubrajaju se grobovi 1, 3, 5, 6–9, 11, 13–19. Treću grupu bi činili grobovi sa najvećom devijacijom, od oko 25 stepeni, i pripadaju joj grob 12 i neistraženi grobovi u njegovoj okolini, koji su definisani samo na osnovi. Po jedan grob iz prve i druge grupe grobova je testiran radiokarbonskim datumima dobijenim iz humanog osteološkog materijala. Rezultati ove analize datovali su vreme smrti pokojnika iz groba 4 iz prve grupe između 670. i 820. godine, a grob 14 koji je određen u drugu grupu između 1420. i 1450. godine. Jedini siguran grobni nalaz je bronzano kalotasto dugme iz groba 4, koje se široko datuje 9–15/16. veka. Nedostatak grobnih nalaza i dva radiokarbonska datuma ne daju pouzdanu osnovu za određivanje početka sahranjivanja tokom rane faze srednjeg veka, već se ova mogućnost treba proveriti dodatnim analizama. Većina grobova ove nekropole može se datovati u kasnosrednjovekovno razdoblje i pretpostavlja se da su pokojnici pripadali jednoj manjoj, verovatno srodničkoj zajednici.

Nekropola iz dvorišta Gimnazije, zajedno sa drugim srednjovekovnim nekropolama otkrivenim u centru grada – Terme, porta crkve, dvorište Muzeja – doprinose boljem poznavanju srpskih naselja koja su postojala tokom srednjeg veka u današnjem centru Čačka. Do sada je utvrđeno da je naseljevanje ruševina kasnoantičkog utvrđenja sa okolinom, po kojem je i nosilo naziv Moravski Gradac, započelo i pre osnivanja Stracimirove zadužbine krajem 12. veka. Trajanje srpskih srednjovekovnih naselja na ovom prostoru odvijalo se vekovima, sve do osmanske okupacije Balkana.

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Use of tools based on large language models and generative AI: No tools.

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BIBLIOGRAPHY OF THE JOURNAL ARCHAEOLOGY AND SCIENCE: 1 (2005) – 20 (2024)

The bibliography of the scientific journal *Archaeology and Science* (ISSN 1452-7448) was compiled on the occasion of the 20th anniversary of the journal's inception and the publication of its 20th volume (vol. 20 (2024)) (**Figure 1**). The goal was to unify the papers to provide insight into the thematic orientation of the articles during the journal's development; as a consequence, book reviews were excluded. The bibliography has 251 references, which are arranged chronologically in order of publication, and within each year by the ordinal number of the article. Each bibliographic unit is processed according to the defined international standard for the bibliographic description of the constituent parts of the publication (ISBD(CP)), with the intentional omission of the heading (surname and first name of the first author), in order to save space. Also, only the first reference within each number is provided in full, while in the subsequent references the repeated data (journal title, issue, and year) is omitted. As the entire bibliography refers to the same source, the title and ISSN of the journal are not repeated in the description. Bibliographic units are given in the language and script in which the works were published. Additionally, below each reference are DOI numbers that lead to the full text of the article.

The publishers of the journal are the Centre for New Technologies Viminacium and the Institute of Archaeology, with the fact that from vol. 19 (2023), the Institute became the primary publisher. From vol. 16 (2020), *Archaeology and Science* also got its online edition with eISSN 2738-1102. In cooperation with the *doiFil* service of the Faculty of Philology of the University of Belgrade, the allocation of DOI numbers to all articles, except book reviews, started with the vol. 16 (2020) as well. During 2021, DOI numbers were also assigned to previous numbers retroactively. Today, the journal is open access, and the works can be used under the CC BY-NC-ND 4.0 DEED license.[1]

In the first 17 volumes, the Editor-in-Chief, as well as the Editor of all volumes, was Dr Miomir Korać. In vol. 18 (2022) and vol. 19 (2023), the editorship was shared by Dr Miomir Korać and Dr Snežana Golubović, so that in vol. 20 (2024), three editorial functions were introduced: Editor-in-Chief - Dr Snežana Golubović, Editor: Dr Miomir Korać and Assistant Editor: Dr Emilija Nikolić. This abolished the previous function of the journal secretary, which was performed from vol. 3 (2007) to vol. 19 (2023), by Dr Nemanja Mrđić (vol.3-vol.5), Dr Olivera Ilić (vol.6-vol.18) and Dr Emilija Nikolić (vol.18-vol.19). The multidisciplinary Editorial Board consists of researchers from Serbia and abroad.

The first two volumes did not have a guide for authors as an integral part of the volume.

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From vol. 3 (2007) to vol. 5 (2009), the journal's policy included publishing works in Serbian, as well as any language widely used in international communication. From vol. 6 (2010) to vol. 12 (2016), the instruction implied publication of papers in Serbian, English, German or French. According to instruction in vol. 13, all papers were published in English, French or German, with a summary in Serbian. Thus, in the first five volumes, the papers were published in Serbian (except for one paper in vol. 3 (2007), which is in English), and from vol. 6 (2010), the papers are in English, along with four papers in German and one paper in Italian. As for the type of contributions; apart from scientific papers, from vol. 5 (2009) (except vol. 8 (2012)), book reviews are also published, which are in Serbian. So far, a total of 30 book reviews have been published, and they will be presented bibliographically in the next issue of the journal. From vol. 1, the tradition of presenting the results of research, protection and presentation of Viminacium on the front page has been maintained (except for vol. 4 (2008)), with the fact that from vol. 20 (2024), the design of the front page has been partially changed.

To date, a total of 187 authors have published their works in the journal. As an auxiliary apparatus of the bibliography, a name register of authors arranged in alphabetical order was created for this paper. Since a non-uniform format of the author's name was observed (with or without a middle letter, with the full name or abbreviated), the full form of the name is listed in the register. For female authors who changed their maiden names, there are cross-references to the surname they use today. Special mention can be made of authors with 10 or more independent or co-authored works, namely: Vanja Korać (26 papers), Milica Tapavički-Ilić (18 papers), Saša Redžić (18 papers), Mirjana Vojvoda (16 papers), Jelena Anđelković Grašar (14 papers), Emilija Nikolić (13 papers), Dragana Gavrilović (13 papers), Angelina Raičković Savić (13 papers), Bebina Milovanović (13 papers), Ljubiša Vasiljević (11 papers), Ilija Mikić (11 papers), Dragan Prlja (11 papers), Miomir Korać (10 papers) and Zoran Davidovac (10 papers).

The affiliation of a total of 497 authorships in a total of 251 papers belong to institutions in Serbia and abroad, while several authorships are without institutional affiliation. The number and share of authorships according to the country of institutional affiliation (along with the number of papers by authors from Serbia that belong to the publishing institutions of the journal *Archaeology and Science*) is given in the **Table 1**.

In conclusion, based on the degree of documentation, scope, completeness, and referencing, as well as the chronological criterion, this work represents a primary, special, selective, retrospective bibliography of the first level. Above all, this bibliography is intended to serve as a useful tool for further scholarly research, which is its primary purpose.

Author's country of institutional affiliation	Number of authorships	Authorship share (%)
Serbia *Publishers of the journal* *Other institution*	388 *227* *161*	78.07 *45.67* *32.39*
Greece	34	6.84
Without institutional affiliation	18	3.62
Italy	6	1.21
Poland	6	1.21
Slovenia	5	1.01
England	4	0.81
Croatia	4	0.81
USA	4	0.81
North Macedonia	4	0.81
Spain	4	0.81
Germany	3	0.60
Romania	3	0.60
Russia	3	0.60
Bulgaria	2	0.40
Czech Republic	2	0.40
Georgia	2	0.40
Turkey	2	0.40
Bosnia and Herzegovina	1	0.20
The Netherlands	1	0.20
Norway	1	0.20
Total	**497**	**100**

Table 1. Number and share of authorships by country of institutional affiliation.

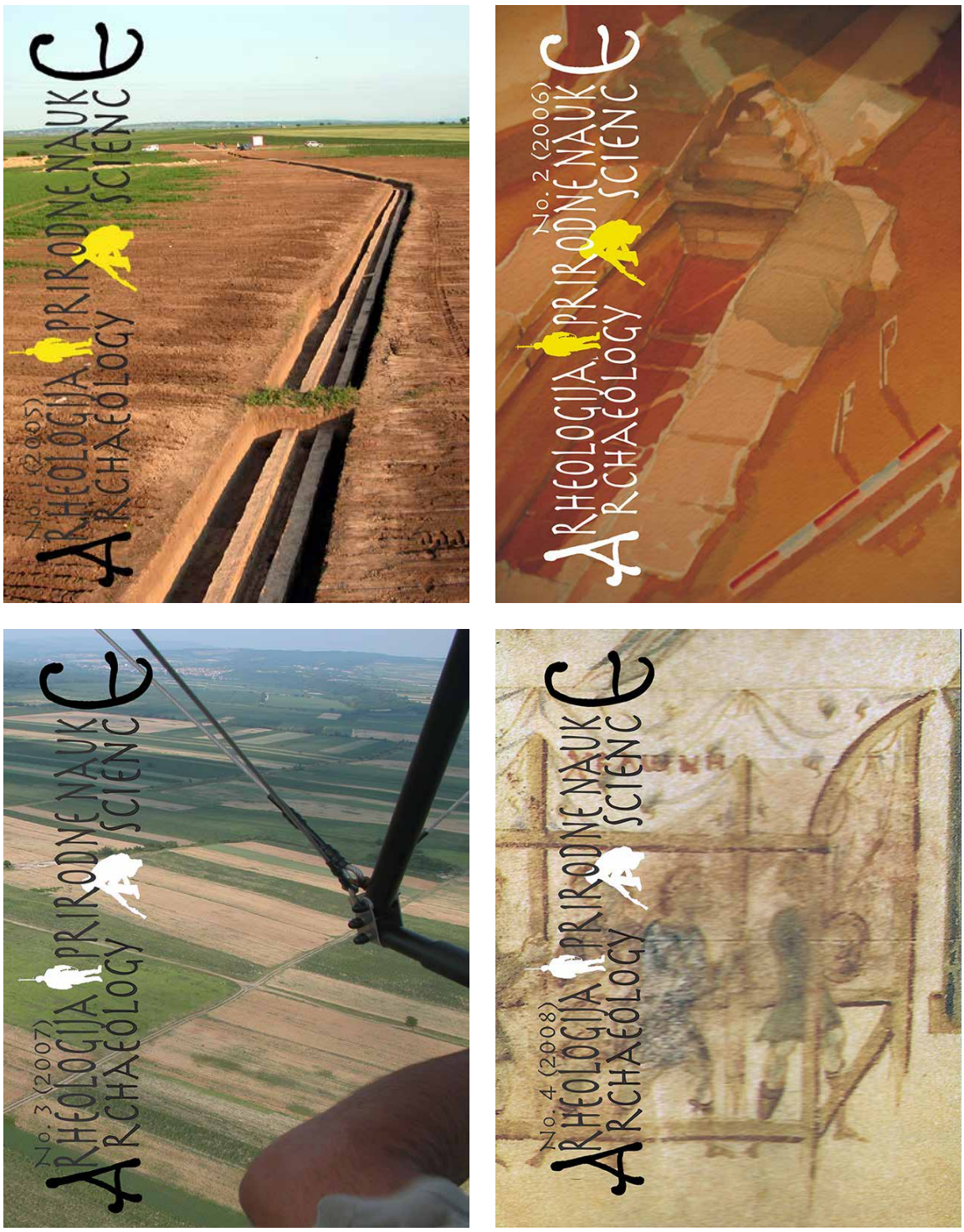

Figure 1. Front covers of all previous volumes.

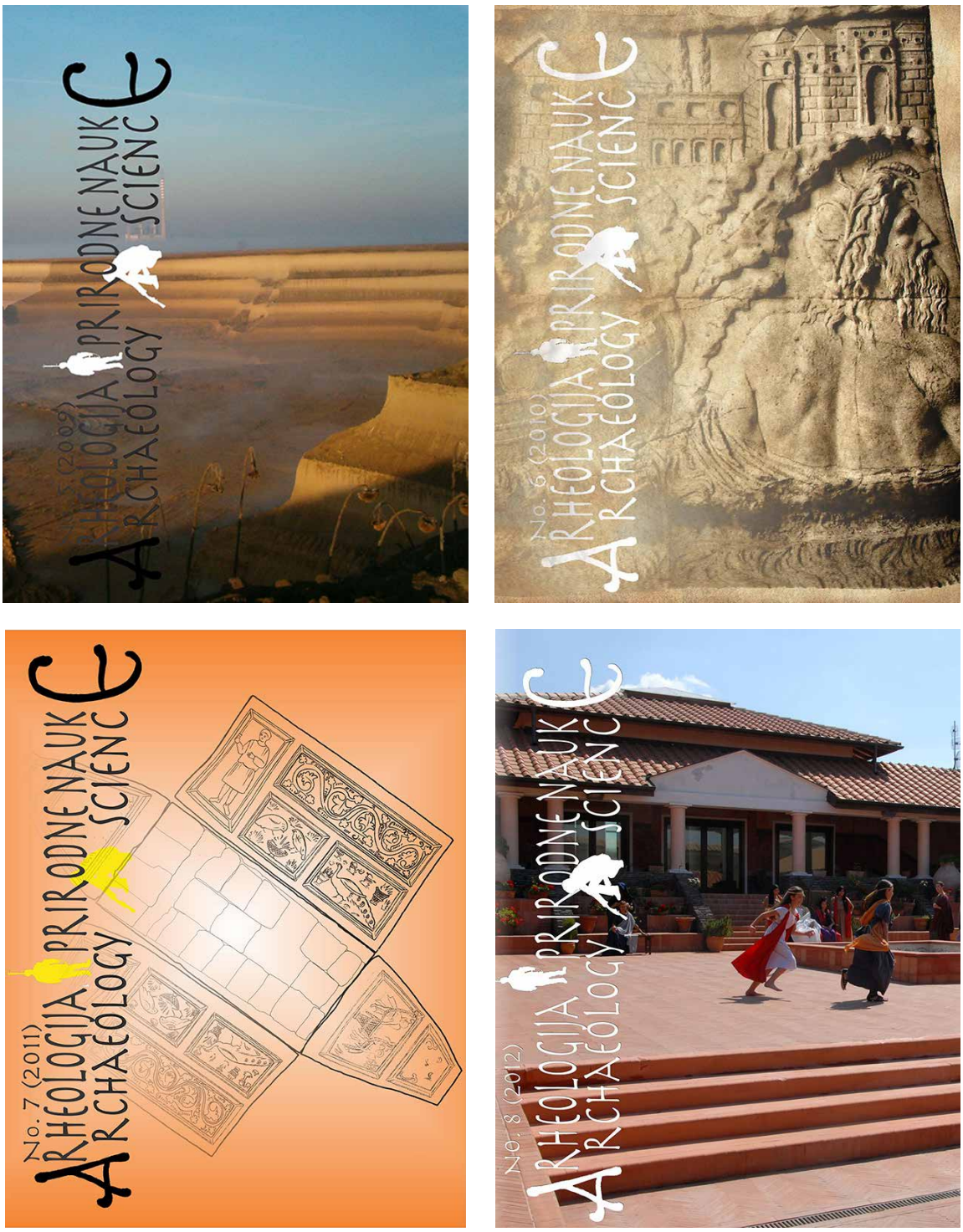

Figure 1. (continued)

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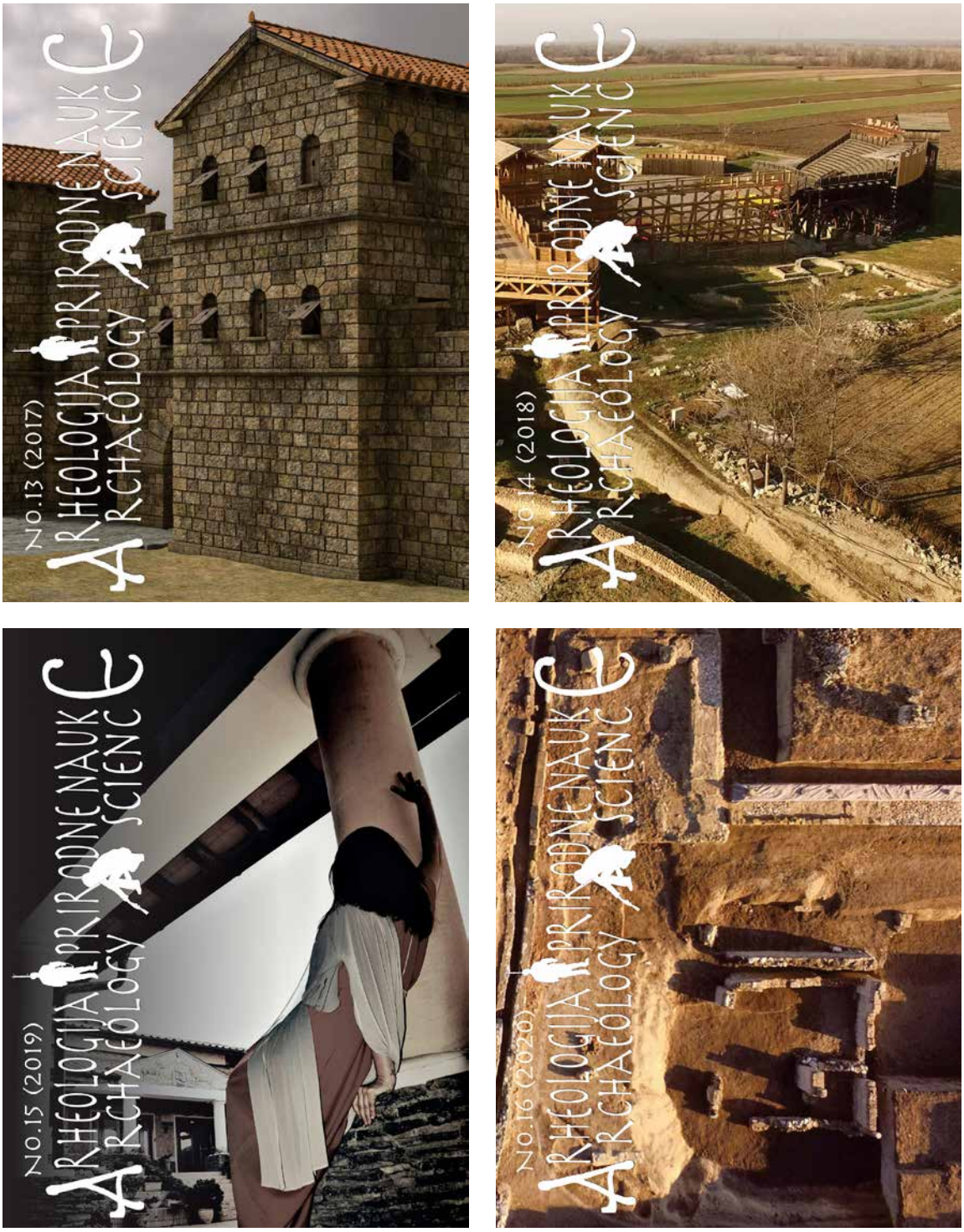

Figure 1. (continued)

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REVIEWS - PRIKAZI

Даница Ђокић, Теодора Бранковић, Марина Радосављевић и Оливера Радосављевић, КОЊ – ЧОВЕКОВ ПРАТИЛАЦ КРОЗ ВЕКОВЕ (каталог изложбе), Пожаревац: Народни музеј Пожаревац, 2022.
(Danica Đokić, Teodora Branković, Marina Radosavljević i Olivera Radosavljević, KONJ – ČOVEKOV PRATILAC KROZ VEKOVE (katalog izložbe), Požarevac: Narodni muzej Požarevac, 2022.)
Katalog sadrži 16 stranica (pet tematskih celina, 25 fotografija sa legendama i jedna ilustracija na naslovnoj strani).

Katalog i izložba „Konj – čovekov pratilac kroz vekove", u organizaciji Narodnog muzeja Požarevac, predstavljali su izazovan zadatak čije se realizacije prihvatila ekipa muzealaca različitih stručnih profila. Izložba sadrži predstave konja na umetničkim i kultnim predmetima i predmetima za svakodnevnu upotrebu, kao i primerke konjske opreme. Nije slučajno da su se ovog poduhvata prihvatili požarevački muzealci, budući da je Braničevski kraj prepoznatljiv po ergelama i konjičkim igrama.

Multidisciplinarni autorski tim činili su Teodora Branković i Olivera Milović (arheologija), Danica Đokić (etnologija) i Marina Radosavljević (istorija umetnosti).

Najstarije poznate predstave konja javljaju se još u paleolitskoj umetnosti, oko 30.000–15.000. godine pre nove ere, ali se u tom periodu konj ne može smatrati za pripitomljenu životinju. Umetnike iz doba paleolita očito su inspirisali susreti sa divljom, neukroćenom životinjom, u kojoj su možda i naslućivali mogućnosti budućeg višemilenijumskog suživota koji je pružio važan doprinos razvoju civilizacije.

Konj je pripitomljen se u periodu 4500–2000. godine pre nove ere i od tada život čoveka postaje neraskidivo povezan sa koristima ostvarenim ukroćivanjem ove životinje, čiji je potencijal znatno olakšao svakodnevni život ljudi i otvorio mogućnosti za njihov lakši i brži razvoj na brojnim poljima. Malo je životinja koje su odigrale tako važnu ulogu u istoriji čovečanstva kao što su konji.

Predstave konja nalazimo na slikama u pećinama nastalim u doba paleolitskih lovaca i dalje na brojnim predmetima tokom narednih praistorijskih epoha. Čest su motiv u grčkom i rimskom stvaralaštvu, bili su inspiracija i srednjovekovnim, renesansnim i baroknim slikarima i vajarima, a njihova jedinstvenost pruža nadahnuće i nama savremenim stvaraocima.

Figura konja uvek je fascinirala umetnike, koji su pokušavali da uhvate trenutak koji oslikava njihov pokret, gracioznost, snagu, moć i lepotu, i na taj način predstave plemenitu životinju kroz različite vidove umetnosti.

Publikacija započinje osvrtom koji je posvećen velikom značaju konja u tradicionalnoj kulturi požarevačkog kraja. Naglašeno je da posebno poštovanje iskazivano prema konju datira na ovim prostorima još iz praistorijskog perioda. Prvi

vidljiv trag praistorijskih verovanja predstavljaju votivni spomenici posvećeni misterioznom kultu Tračkog konjanika.

Odsjaj tog drevnog kulta verovatno iskri i danas kroz legendu povezanu sa tzv. Todorovom nedeljom, prvom nedeljom Uskršnjeg posta, pošto se veruje da tada tokom noći izlaze todorci, konji sa jahačima ili bez njih, i u grupi od sedam ili devet prolaze kroz sela i ostavljaju tragove kopita. Predvodio ih je Veliki Todor, kome je bila posvećena Todorova subota. Navedene sedmice noću se nije izlazio iz kuće jer bi mogući susret sa todorcima mogao biti koban. Tokom ove nedelje posebna pažnja se posvećivala konjima, što predstavlja potvrdu odsjaja poštovanja proisteklog iz drevnog kulta.

U okviru vlaške kulture kult konja ostao je očuvan u nazivu kobilin četvrtak za dan u Todorovoj nedelji. Na kobilin četvrtak konji su se timarili, potkresivali su im se repovi i projahivani su po dvorištu. U nekim delovima Braničevskog okruga organizovale su se povorke pod maskama (učesnici su nazivani čiče ili todorci), dok su u Stigu i Pomoravlju na Todorovu subotu organizovane konjičke trke.

U tradicionalnoj kulturi braničevske oblasti konji su se koristili u privrednim delatnostima i saobraćaju, dok su posebno važnu ulogu imali u svadbenom ritualu. Retka su bila domaćinstva koja nisu posedovala bar jednog konja, a broj grla i rasa simbolisali su ekonomsku moć porodice.

Jedinstven odnos prema konjima izražavao se kroz izuzetnu pažnju poklanjanu konjskoj opremi, a nju su izrađivale zanatlije sarači i sedlari (satleri). Posebna celina u publikaciji posvećena je saračkom zanatu. Naglasak je stavljen na Zanatsku izložbu, organizovanu 1894. godine u Požarevcu, pod pokroviteljstvom kralja Aleksandra Obrenovića. Za pripremu izložbe osnovan je Izložbeni odbor, u kojem su važnu ulogu imali sarači i sedlari.

Požarevački sarači predstavljali su imućne zanatlije, jer je razvijeno konjarstvo uslovljavalo veliku potrebu za njihovim proizvodima. Tome u prilog išlo je i prisustvo vojske sa razvijenom konjicom. Danas se ovim, nekada elitnim, zanatom bavi samo jedan mladi sarač. Navodi se da bi njegov rad trebalo podržati, jer on ne predstavlja samo deo nacionalne kulturne baštine i identiteta, već i neophodnost današnjeg vremena.

Opisane priče ilustrovane su sa deset fotografija: kmet sela Dobre na konju, zavetina u Neresnici, detalji svadbenih običaja, majstori i kalfe ispred radnji i obrada kože na reslu.

Predstave konja u antičkoj umetnosti su česte i nalaze se na predmetima različite namene. Mogu se videti na nadgrobnim spomenicima, freskama, mozaicima, gemama, ikonama, novcu, ali i predmetima za svakodnevnu upotrebu poput fibula ili posuđa. Izrađivani su od različitog materijala poput bronze, olova, poludragog kamenja, mermera ili krečnjaka.

U antičkoj arheološkoj zbirci Narodnog muzeja Požarevac čuvaju se brojni eksponati sa predstavama konja, ali i delovi konjske opreme. Najbrojniju grupu predmeta čine votivne ikone na kojima su, u okviru ikonografije kultova različitih božanstava, prikazivani i konji. Mogu se podeliti u tri grupe: ikone Mitrinog kulta (najbrojnije), ikone Tračkog konjanika i ikone Podunavskog konjanika. Na ikonama se ne nalaze predstave božanstava zvaničnog rimskog panteona, već scene iz kultova orijentalnog i lokalnog porekla. Izrađivane su u lokalnim radionicama. Postojanje radionice za izradu olovnih ikona Podunavskog konjanika potvrđeno je u Viminacijumu. Na ikonama ovog kulta prikazana su najčešće dva konjanika koja iskazuju gest poštovanja prema lunarnoj boginji predstavljenoj između njih, što dokazuje boginjinu dominantnost u kultnom sadržaju. Pored olovnih, pronalaze se i ikone izrađene u bronzi i mermeru.

Predstava Tračkog konjanika nalazi se i na sarkofagu sa girlandama, smeštenom u lapidarijumu požarevačkog muzeja. U ovom slučaju konjanik predstavlja heroizovanog pokojnika i povezuje se sa verovanjem u besmrtnost duše.

Na izložbi i u publikaciji zastupljeni su i glinena opeka sa kentaurima (Kostolac–Kapija), gema od poludragog kamena (Kostolac–Viminacijum), podni mozaik od kamena i maltera sa predstavama kentaura i konja u trku (Kravlji Do–Klisura) i novac sa dvoprezima (biga), četvoroprezima (kvadriga) i konjanicima na reversnoj strani.

Na izložbi je predstavljena i konjska oprema iz srednjovekovne arheološke zbirke. Predmeti

čuvani u ovoj zbirci dospeli su u muzej na različite načine – putem sistematskih arheoloških istraživanja, poklonom i otkupom.

Prilikom sistematskih arheoloških istraživanja grada Braničeva, sprovedenih u periodu 1985–1987. godine, na lokalitetu Rudine otkriven je par gvozdenih piramidalnih mamuza i par gvozdenih potkovica datovanih u 12–13. vek.

Kao poklon, iz Rama je 1990. godine dospeo izuzetan nalaz – ostava ratne opreme koja je sadržala sekiru, dva noža, par mamuza, par uzengija, đem i žvalu izrađene od gvožđa u tehnici kovanja. Ostava je pripadala vojniku-konjaniku i vremenski je određena identično kao i prethodno opisani nalaz.

Preko otkupa iz Bradarca je nabavljen bronzani amulet sa predstavom konja u kasu sa konjanikom i otvorom za pričvršćivanje probušenim kroz glavu ljudske figure. Amulet je nastao u 9. veku. Iz Dubravice je na isti način muzej obogaćen nalazom srebrnog oglava za konja. Oglav je korišćen za kićenje konja prilikom važnih svetovina. Izrađen je tehnikama livenja i iskucavanja i težak je 784 grama. Potiče iz relativno novijeg vremena, kraj 19. početak 20. veka.

Što se tiče savremene umetnosti, na izložbi su predstavljene slike Bože Prodanovića, Danice Masniković, Radislava Trkulje, Trajka Stojanovića Kosovca, Miroslava Arsića, Branimira Karanovića, Živka Đaka, Paška Bartolina i drugih.

Slike su nastajale u periodu od sedme decenije 20. veka do završne godine prethodnog milenijuma. Najstarija slika, delo Bože Prodanovića, naslikana je 1964. godine i predstavlja deo Legata Miodraga Markovića, koji se čuva u Požarevcu. Najmlađa zastupljena slika delo je Radislava Trkulje nastalo 2000. godine u okviru Likovne kolonije Ljubičevo, čiji je jedan od organizatora bio i Narodni muzej Požerevac.

Reči koje u publikaciji beleži Olivera Milovac, da konj na leđima istoriju nosi, jasno navode na razmišljanje u kom pravcu bi tekao celokupan razvoj ljudske civilizacije i kulture da čoveku nije bio na raspolaganju suživot sa ovim plemenitim kopitarom.

Multidisciplinarna izložba požarevačkog muzeja predstavljala je zahtevan zadatak i ukazala na cilj do koga se može dospeti kada svoja znanja i ideje udruže stručnjaci različitih profila i pruže zajednički doprinos obradi jedne kompleksne tematike.

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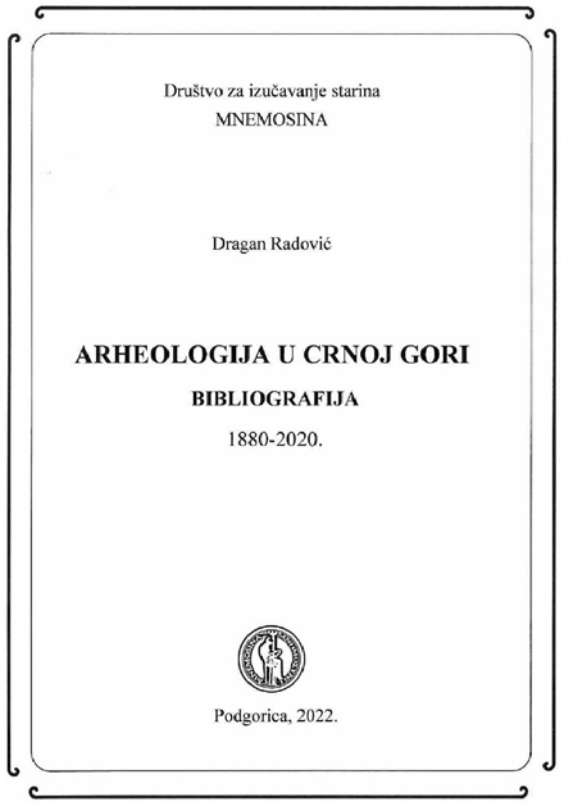
Dragan Radović, ARHEOLOGIJA U CRNOJ GORI: BIBLIOGRAFIJA 1880–2020. Podgorica: Društvo za izučavanje starina MNEMOSINA, 2022. Publikacija sadrži 181 stranicu (1105 bibliografskih jedinica podeljenih u tri grupe i tri registra). ISBN 978-9940-9501-2-5.



Bibliografije nisu samo spiskovi radova – one su svedočanstva vremena, tihe hronike traganja za znanjem i nastojanja da se ono sistematski sačuva za buduće generacije. Knjiga *Arheologija u Crnoj Gori: bibliografija 1880–2020.* Dragana Radovića jeste upravo takva građa: brižljivo vođen bibliografski put kroz više od jednog veka arheoloških istraživanja na prostoru Crne Gore. Ova publikacija ne samo da sistematizuje obimnu naučnu građu već i osvetljava tokove arheološke misli, upućujući čitaoca na procese znanja koji su oblikovali razumevanje kulturne baštine ovog prostora.

Knjigu je objavilo Društvo za izučavanje starina Mnemosina iz Podgorice 2022. godine, kao drugo, izmenjeno i dopunjeno izdanje prvobitno publikovano 2018 godine. Autor ove obimne bibliografije, Dragan Radović, arheolog i dugogodišnji kustos, dao je značajan doprinos istraživanju i očuvanju kulturne baštine Crne Gore, posebno u oblasti arheološke dokumentacije i prezentacije.

Celokupno znanje i istraživanja na polju arheologije u periodu od 1880. do 2020. godine u Crnoj Gori obuhvaćeni su kroz 1105 bibliografskih jedinica knjižne građe. Knjiga je podeljena na nekoliko celina, koje omogućavaju lak pregled i snalaženje.

U uvodnom delu autor nudi kratak istorijat arheoloških istraživanja na prostoru Crne Gore, kao i metodološke smernice primenjene pri izradi bibliografije.

Središnji deo publikacije čini pregled objavljenih radova poređanih abecednim redom, dok su radovi jednog autora navedeni hronološki. Uz pojedine bibliografske jedinice dodata je i anotacija koja preciznije objašnjava sadržaj navedenog teksta.

Autor naglašava da mu ambicija nije bila da Bibliografija bude konačna ni iscrpna, već da predstavlja pokušaj objedinjavanja što većeg broja bibliografskih jedinica o arheološkim istraživanjima i lokalitetima u Crnoj Gori, kako bi se budućim istraživačima olakšao dalji rad.

Određene bibliografske jedinice nisu striktno vezane za arheologiju, već se bave temama iz oblasti kulturne istorije ili istorije umetnosti, ali su uključene zbog svoje relevantnosti za proučavanje pojedinih arheoloških tema. U Bibliografiju su uvršteni radovi objavljeni u domaćim i stranim izdanjima, ukoliko se odnose na prostor Crne Gore. Samim tim, znatan deo publikacije čine i radovi stranih autora.

Bibliografske jedinice raspoređene su u tri grupe, prema tipu publikacije i značaju za arheološku građu:

Monografske publikacije – među kojima se izdvajaju radovi koji sintetizuju duže periode istraživanja ili se bave pojedinačnim lokalitetima. Na primer, zapaženo mesto zauzimaju publikacije o Duklji, kako domaćih tako i stranih autora. Posebno je značajno delo *Archäologische*

Forschungen in Albanien und Montenegro, u kojem austrijski arheolozi Kamilo Prašniker (Camillo Praschniker) i Arnold Šober (Arnold Schober) objavljuju rezultate svojih istraživanja ilirskih gradova u Crnoj Gori. Ova izdanja, naročito brojna u poslednjim decenijama 20. veka, predstavljaju temeljna naučna dela crnogorske arheologije. U ovom delu zabeleženo je 85 bibliografskih jedinica.

Prilozi u časopisima, zbornicima radova, monografijama i listovima – najbrojnija grupa sa čak 983 bibliografske jedinice. Obuhvata tematski raznovrsne tekstove, često prezentovane na naučnim skupovima ili kao rezultat terenskih istraživanja. Među autorima se izdvajaju Đuro Basler, Rikardo Belkari (Riccardo Belcari), Aleksandrina Cermanović-Kuzmanović, Jelena Cvijetić, Dejan Gazivoda, Predrag Lutovac, Maja Parović-Pešikan, Karl Pač (Karl Patsch) i dr., čiji se radovi pojavljuju u *Arheološkom pregledu*, *Glasniku Zemaljskog muzeja Bosne i Hercegovine*, *Starinaru*, *Glasniku Srpskog arheološkog društva* i ostalim monografskim i periodičnim izdanjima.

Izložbeni katalozi i vodiči – prate izložbe ili upućuju na važne muzeje i galerije u kojima se čuva i prezentuje arheološka građa. Iako često marginalizovani u akademskim krugovima, ovi zapisi imaju posebnu vrednost za celovit uvid u arheološku delatnost u Crnoj Gori. Ova grupa uključuje 35 bibliografskih jedinica.

U četvrtom, završnom delu publikacije nalazi se Registar imena, kao i dva dodatna reistra: Registar periodičnih izdanja i Registar arheoloških lokaliteta i toponima. Ovakvi registri, nezaobilazan prateći element bibliogarfije, omogućavaju brzo i precizno pretraživanje građe po različitim kriterijumima, što znatno olakšava dalji istraživački rad.

Zbog svoje obimnosti, preglednosti i sistematičnosti *Arheologija u Crnoj Gori: bibliografija 1880–2020.* zauzima posebno mesto u stručnoj literaturi. Ona nije samo vodič kroz postojeće izvore već i podsetnik na odgovornost koju imamo prema znanju – da ga prikupimo, očuvamo i učinimo dostupnim onima koji dolaze posle nas. U tom smislu Radovićeva publikacija prevazilazi okvire arheologije i postaje dragocen dokument kulturnog pamćenja Crne Gore.

U kontekstu stručnog bibliotekarskog rada, publikacije ovog tipa olakšavaju katalogizaciju, omogućavaju preciznije informisanje korisnika i doprinose očuvanju intelektualnog i kulturnog nasleđa. Značaj ovakvog bibliografskog pregleda posebno dolazi do izražaja u manjim i specijalizovanim bibliotekama, gde je pristup relevenatim izvorima ponekada otežan, a ovakva publikacija služi kao pouzdan most ka celokupnoj naučnoj zajednici.

Ova bibliografija, iako na prvi pogled tiha i nenametljiva, zapravo je moćna veza između prošlosti i budućnosti – poziv istraživačima da nastave put ka razumevanju i očuvanju bogatog arheološkog nasleđa Crne Gore.

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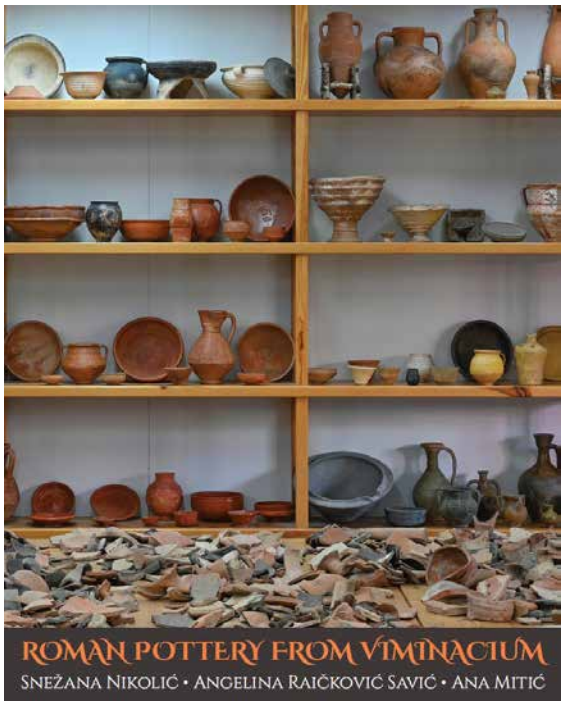
Snežana Nikolić, Angelina Raičković Savić and Ana Mitić: ROMAN POTTERY FROM VIMINACIUM. Belgrade: Institute of Archaeology, 2023. Publication contains 511 pages. ISBN 978-86-6439-084-2.



Ceramic vessels are among the most numerous material relics found at sites affected by the Romans. *Viminacium*, in the province of *Moesia Superior*, on the territory of present-day Serbia, is no exception. The favourable geographical location and proximity to trade routes enabled long-term development, which is evidenced by ceramic finds of Roman provenance. These are local and imported vessels found in the objects examined so far. The local products include vessels from local craft workshops, which often imitate imported forms. These appear at the site throughout the Roman period in varying quantities. The material, firing, and decoration of the vessel itself, linked to the context of the find, play an important role in determining its origin. They also present us with information related to the popularity of types and forms, depending on the geopolitical situation. The present review refers to the monographic publication by S. Nikolić, A. Raičković Savić, and A. Mitić, which presents the finds of Roman pottery from previous and new excavations at the *Viminacium* site. The thematic front cover corresponds to the contents and also presents selected ceramic vessels in colour. The authors' research is presented in English in the publication itself, with the text arranged in two side-by-side columns, which is partially supplemented by photographs and illustrations. In the introduction, the authors give us a brief history of the settlement of the site, from the prehistoric to the early Byzantine period. They also summarize previous research and publications on the pottery from *Viminacium*. Additionally, they explain the typology used and the format of the publication, which consists of six chapters, a bibliography, a catalogue, and a tabular appendix. The individual chapters are organised chronologically, arranged into subchapters according to the functional typology of vessels. The introductory chapter concludes with a chronological delineation of the different types of vessels, as they have changed in terms of production, function and typology.

The first chapter includes finds from the last decade of the 1st to the middle of the 2nd century. In it, the authors present individual objects of the oldest types of Roman pottery. These include the recently excavated north-western part of the military camp, the suburban areas and the southern necropolis. Among the tableware, the authors present especially luxurious vessels, such as *terra sigillata*, classified according to typology by H. Dragendorff (Dragendorff 1895). In this early period, it is the so-called smooth terra sigillata, which has a smooth surface. It is represented by forms such as Drag. 25, Drag. 35, Drag. 36 and Drag. 17b. The authors date them to the Flavian period and they are represented mainly by bowls and plates from northern Italian centres. Other types are thin-walled vessels, represented primarily by small bowls with a grey firing colour. Vessels with marbled surfaces include, for example, plates of various shapes or calotte-shaped bowls. It is interesting

to note that there appear to be vessels influenced by Late La Tène forms, most often "S"-profile bowls, beakers and jugs with handles. The kitchen pottery of this period is represented by coarse-walled bowls and pots of a grey, red, brown and black matte surface with simple decoration including grooves or incised lines. Along with bowls and pots we also identified lids. Another type is the early *mortaria* of Italian origin, classified by the authors according to the typology by Lj. Bjelajac (Bjelajac 1994), which is based on the typology by K. F. Hartley (Hartley 1973) as group I, type 1, or type 2. The last that are represented in this subchapter are handmade vessels. These are vessels created by local craftsmen. In addition to the tradition of autochthonous pottery, the authors also identify elements like handmade pottery from *Dacia*. Other pottery from this period includes storage pottery, especially pithoi, which occur in two groups. The first was influenced by the La Tène style. These were fired in shades of grey, and their surface was unevenly polished. The second is characterised by the specific texture of the clay used. They were fired in shades of red and orange with a black resin coating. Finally, the authors present transportation pottery, which primarily consists of amphorae. The authors classify these based on the typologies by Lj. Bjelajac (Bjelajac 1996) as type I and type III. The most frequent type being *amphorae* with sharply tapered bases ending in a knob, referred to as type 6B by H. Dressel (Dressel 1899). These amphorae are marked with stamps that allow us to determine their origin. Based on the contents, manufacturing method or imperial stamps, the authors identified their origin and dating. For the *amphorae,* there are also lids of different shapes and sizes. In addition to their transport function, *amphorae* also had a secondary use, such as building material or in cremation burials, when the ashes were placed in a vessel.

In the second and longest chapter, the authors continue with the next phase of settlement from the middle of the 2nd to the 3rd century. *Viminacium* flourished during this period and underwent simultaneous military, economic, and cultural changes, as evidenced by pottery. As in the previous chapter, the subsection begins with table pottery, which in this period is represented by *terra sigillata*. The authors here identify forms as Drag. 33, Drag. 32, Drag. 18, and Drag. 18/31. Additional identifications include bowls with collars as Drag. 38, *mortaria* Drag. 43, and plates Drag 40. The amphorae are identified, through their stamps and decoration, as being from the Middle Gaulish workshop of Lezoux, as well as Germanic workshops such as Rheinzabern and Westerndorf. Glazed vessels were also found, which were identified, on the basis of the typology by T. Cvjetićanin (Cvjetićanin 2001), as group A and A1. The finds are mainly plates, bowls, and jugs, the surfaces of which are decorated with yellow, olive-coloured, brown or green glaze. Specifically, the jugs are decorated white sickle-shaped ornament, made in the barbotine technique. The jugs were discovered at the amphitheatre site. Of note are the *paterae*, with a smooth, olive-green glaze on their surface, and which have plaque-shaped handles with circular flared ends. Parallels have been found in *Pannonia*, especially in *Aquincum*. The local production imitated thin-walled bowls - Flavian vessels; *terra sigillata* mainly in the form of Drag. 35, Drag. 36, or Drag. 32; as well as vessels with relief decorations, from the so-called *Viminacium–Margum* workshop, which were equally as popular as the originals and distributed to other regions, according to the authors. Other vessels presented by the authors are beaker-cups with two handles and jugs with a wide trefoil opening. Kitchen pottery did not change significantly since the previous period (the last decade of the 1st to the middle of the 2nd century), but vessels made of kaolin clay, such as bowls or pots with handles, became more prominent. In addition to common vessels, the authors also point out finds that they classify as kitchen utensils. These are *mortaria*, strainers and casseroles without relief decorations. Storage vessels are represented by pithoi in an unchanged form, but large pots also appear. Regarding pithoi, local production imitated older types, but with a difference in their volumes. As for transport pottery, amphorae originating typologically from northern Italy, Istria, or the Aegean areas appear in smaller quantities. The authors present large amphorae, for example the Camulodunum 176 type or the smaller-sized *amphorae* type XIII and XIV by Bjelajac (Bjelajac 1996). Amphorae also

appear from local workshops, used for storing and transporting liquid products.

The third chapter deals with the late Roman period, beginning with the crisis of the empire in the middle of the 3rd century and ending with the invasion of the Huns in the 5th century. These events manifested themselves in social differentiation, which was accompanied by the dominance of local pottery at the expense of imported wares. There is also evidence of a lower quality of vessels, caused, according to the authors, by mass production, as evidenced by the finds in the kilns. Kitchen vessels are the most numerous, especially pots, bowls, and lids. The authors also report fewer vessels made from the so-called kaolin clay in this period. There are older as well as newer forms present in the assemblage of finds. Lids are characterised by a groove incised along the inner edge of the rim, a sandy texture and a grey to brown firing colour. As in the previous period, numerous kitchen utensils, including collared glazed and unglazed mortaria, were found. In the case of mortaria, the authors found a variety of stamps, such as a stamp on an unglazed mortarium with the name of the craftsman *IVSTINIANVS* in a narrow rectangular frame. His workshop was located in Ptuj, ancient *Poetovio,* in *Pannonia*. In addition, there is also so-called federate pottery made of high-quality clay, with a grey firing colour and forms influenced by foreign styles. Of the table pottery, the authors report a continuation of the same vessel types, but glazed pottery still predominates, primarily jugs, but also bowls, plates, and cups. Glazed vessels were olive-coloured, brown, brown green glaze and dark yellow glaze. Other table vessels were made of well-purified clay and fired in shades of grey and red. Luxury vessels are represented by *terra sigillata* from the Pfaffenhofen workshop or imitations of vessels made using the *terra sigillata* technique. The authors also found a small number of luxurious vessels from North African centres. The storage pottery represented by pithoi underwent only minor changes; as the authors note, these include wider handles placed beneath the rim with simple decorations, probably products of a local workshop. Only a small number of transport *amphorae* were found at the site. These include amphorae from Black Sea and North African areas. In typological terms, these are types with large handles overhanging the rim or small fluted *amphorae*, probably originating from Black Sea centres.

In the next chapter, the authors discuss vessels with a special function. In this group they include *clepsydrae* – time-measuring vessels, coin banks, and miniature vessels. Only two examples of *clepsydrae,* a two-part vessel, were found at the site. The upper part is a bowl of the form Drag. 37 and lower part has the form of a jug. These were found in a cremation grave, in the southern necropolis. The authors also mention four examples of coin banks. These small vessels, found at the western entrance to the amphitheatre, are different shapes, and have a slit on the closed top. The miniature vessels are smaller versions of beakers and bowls. A separate subchapter is devoted to vessels used in ritual ceremonies. These are censers, which the authors have classified into 36 types of different sizes, made of well-purified clay and fired in a red, grey or brown firing colour. About 40 prosopomorphic vessels were found on the site, but only parts of most of them have been preserved. Other items include ceramic bottles, similar to the glass balsamaria found in the southern necropolis. Some vessels are similar to Greek kraters – vessel for mixing wine. These are decorated with relief motifs such as a rooster, eagle or theatrical masks, which the authors associate with the *Bacchus/Dionysus* cult. Included among the ritual vessels are those with handles shaped like snakes, also found in *Pannonia* and *Dacia*. Another vessel type is the so-called "kernos": small, handmade vessels, with an uneven wall thickness, roughly processed surfaces, and mostly red in colour, which have also been discovered in the southern necropolis. The final subsection includes vessels of unknown function, comprising a few specimens without known parallels or an interpretable purpose.

The penultimate chapter is devoted to ceramic vessels from graves. Primarily, these are urns with lids, preserved from the necropolis. Vessel types with secondary uses were often used as urns, especially kitchen vessels, but also storage or transport vessels. These urns mostly contained cremated remains, along with additions such as coins, which assisted the authors in a more

precise dating. Ceramic vessels as grave goods form a separate subsection of the publication. Mostly these are jugs of various sizes, but also small and large bowls, and beaker-cups, placed in inhumation and cremation graves. According to the authors, there are other examples of grave goods that include locally made vessel, often bowls and plates similar to forms Drag. 35, and Drag. 36, from cremation graves dated into the 2nd century. Handmade vessels are found in the southern and eastern necropolis. These include pots decorated with incised lines. According to the authors, not all types of vessels were used during burials.

In the concluding remarks, which are the last chapter of the publication, the authors present the typological variations of individual vessels, their shapes and forms, as well as their production and distribution in the different periods of settlement. They also present the context of the finds, along with donated specimens from each structure. Together with a summary of the content of the chapters, they offer scope for further potential research. A clear bibliography is followed by appendices, a catalogue, and tables. The catalogue lists the vessels separately, divided by type into bowls, pots, plates, *amphorae*, lids, pithoi, colanders, small bottles, jugs, censers, prosopomorphic vessels, jugs, miniature vessels, and *paterae*. Each specimen is pictorially illustrated and numbered. Below this is a detailed description of the find, dimensions, find context, and its dating. Tables listing the find number, vessel type, dating, and find area (urban centre, military camp, suburban zone, or necropolis) conclude the publication.

The work has a few shortcomings, among them the absence of a scale for the drawings in the catalogue, or a description of the scale or dimensions used in the illustrations. In general, the work represents a comprehensive summary and subsequent study of all the Roman vessels discovered so far at the *Viminacium* site. Thanks to the typological and chronological division of the individual vessels, we can trace the evolution of the settlement and its economic, social, and cultural development. The authors have also brought to light the deeper significance of the province of *Moesia Superior* in the context of trade within the empire. At the same time, the publication also provides scope for research on Roman pottery from other scholarly disciplines.

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Александра Савић и Сања Врзић, МУЗЕЈИ И КОМУНИКАЦИЈА С ПУБЛИКОМ У 21. ВЕКУ - САВРЕМЕНЕ ПРАКСЕ, Београд: Музејско друштво Србије, 2024. ISBN-978-86-80352-05-3
(Aleksandra Savić i Sanja Vrzić, MUZEJI I KOMUNIKACIJA S PUBLIKOM U 21. VEKU - SAVREMENE PRAKSE, Beograd: Muzejsko društvo Srbije, 2024. ISBN-978-86-80352-05-3)
Publikacija sadrži 209 stranica.

Monografija *Muzeji i komunikacija s publikom u 21. veku savremene prakse* dr Aleksandre Savić, biologa i muzejske savetnice u Prirodnjačkom muzeju, i Sanje Vrzić, muzejske savetnice Narodnog muzeja Zrenjanin, značajno doprinosi sistematizaciji i analizi savremenih komunikacionih praksi u muzejskom sektoru Srbije. Autorke pružaju jasne okvire i primere za primenu novih tehnologija, društvenih mreža i PR strategija u funkciji otvaranja muzeja ka publici, i uvodeprepoznatljivu terminološku i metodološku strukturu koja do sada nije bila celovito obrađena u domaćoj literaturi. Recenzent monografije je dr Nikola Krstović.

Više od dve decenije autorke, muzejske savetnice, prisutne su na muzeološkoj sceni Srbije na poslovima odnosa s javnošću, sa zapaženim projektima za koje su, između ostalih, dobitnice nagrade „Mihailo Valtrović" 2024. godine za koautorsku izložbu „Hilandarski medicinski kodeks i srpska srednjovekovna medicina" (Aleksandra Savić) i nagrade „Zlatni doboš" za uspešnu saradnju sa medijima i prezentovanje zrenjaninskog muzeja u javnosti 2006. (Sanja Vrzić). Zbirno su realizovale više od hiljadu medijskih kampanja muzeja, što je propraćeno mnogobrojnim objavama na društvenim mrežama, tekstovima, prilozima i gostovanjima.

Na početku knjige *Reč autora* nam pojašnjava nastanak monografije i nameru autorki da napišu publikaciju (priručnik) za one koji tek počinju da se bave muzejskom komunikacijom, kao i za sve one kojima su potrebne dodatne ideje ili informacije iz tematske oblasti koju tekstovi iz knjige pojašnjavaju.

U prvom poglavlju knjige *Muzeji i muzejska komunikacija* autorke razmatraju šta je muzej i komunikaciju kao muzeološku funkciju. Ovo uvodno poglavlje pruža teorijski okvir za razumevanje savremenog muzeja kao komunikacionog prostora kroz prizmu prenosa određene poruke. Autorke analiziraju istorijski razvoj muzeja, od institucija s fokusom na kolekciju i ekspertsku interpretaciju do interaktivnih i društveno angažovanih prostora koji promovišu dijalog sa zajednicom. U poglavlju se razmatraju: definicije muzeja prema ICOM-u i savremeni izazovi te definicije, teorije komunikacije u kontekstu kulturnih institucija i muzej kao medij. Ključni naglasak je na tome da komunikacija nije samo prenos informacija već i proces zajedničkog značenja, uključujući publiku kao koautore.

U drugom poglavlju *Publika u muzeju* autorke objašnjavaju obrazovnu ulogu muzeja i njegovo mesto u neformalnom obrazovanju. Savremeni muzej postavljaju kao prostor sticanja znanja kroz iskustvo, dijalog, kreativnost i interakciju. U

ovom delu publikacije obrađene su teme kao što su dizajn obrazovnih programa za različite starosne i interesne grupe i metode učenja zasnovane na projektima, igri i aktivnom učešću sa aspekta radionica, interpretativnih tura i kreativnih radionica (npr. za decu, porodice, starije). Priloženi su primeri programa i radionica u Narodnom muzeju Srbije, Etnografskom muzeju, Muzeju Vojvodine, Narodnom muzeju Kikinda, u Galeriji Matice srpske, Zavičajnom muzeju Knjaževac, Muzeju primenjene umetnosti, Muzeju savremene umetnosti, Muzeju rudničko-takovskog kraja kao i primeri iz Narodnog muzeja Valjevo i Narodnog muzeja Zrenjanin. Istaknuta je važnost saradnje sa školama, vrtićima i univerzitetima kao i uloga muzejskih pedagoga i značaj kontinuiranog usavršavanja.Takođe se razmatra integracija digitalnih alata u obrazovanje (virtuelne ture, edukativne aplikacije) i muzeji kao prostori inkluzivnog učenja za osobe sa invaliditetom.

Naredno poglavlje *Muzeji i nove tehnologije* predstavlja jedan od najaktuelnijih i najinovativnijih delova publikacije. Ono se bavi transformacijom muzeja u digitalnom dobu i uvodi čitaoca u praktične i teorijske aspekte primene novih tehnologija u muzejskoj komunikaciji, edukaciji i prezentaciji kulturnog nasleđa. Autorke polaze od teze da digitalna transformacija nije samo tehnička adaptacija već temeljna promena u poimanju uloge muzeja u društvu. Oni više nisu samo fizički prostori već i virtuelni resursi dostupni široj publici. Tehnologija se tumači kao alat za demokratizaciju pristupa kulturnom nasleđu, i posebno se naglašava značaj digitalnih strategija u kontekstu postpandemijske publike. Dalje, autorke, kroz mnoštvo primera i fotografija, razmatraju primenu informaciono-komunikacionih tehnologija (e-vodiči i *touch-screen* ekrani u izložbenim prostorima, mobilne aplikacije, digitalni eksponati, AR/VR – virtuelna i proširena realnost, QR kodovi i NFC tehnologija) u muzejima u Srbiji. Naglašeno je da tehnologija ne sme da bude samo „dodavanje efekata" već mora biti u službi sadržaja i publike. U posebnom segmentu razmotrena je i upotreba veštačke inteligencije (AI) u muzejima, a autorke ističu da je treba posmatrati kao dodatni alat paralelno sa ljudskim resursima. U okviru ovog poglavlja autorke ističu i komponovanu muziku, koja može biti moćan resurs u stvaranju nezaboravnog izložbenog doživljaja, posebno kada je pažljivo usklađena s temom i porukom postavke.

Četvrto poglavlje *Muzeji i društvene mreže* predstavlja analizu ubrzane digitalne transformacije muzeja u kontekstu rasta i uticaja društvenih mreža kao platformi za komunikaciju, promociju i izgradnju odnosa s publikom. Autorke ističu da je prisustvo muzeja na mrežama poput Fejsbuka, Instagrama, Tvitera (X), Jutjuba i Tiktoka postalo ne samo očekivano već i neophodno za institucije kulture koje žele da održe relevantnost u javnom prostoru. U poglavlju se društvene mreže sagledavaju kao alati za dvosmernu komunikaciju, kroz koju muzeji ne samo da promovišu svoje programe već i aktivno grade publiku, podstiču interakciju, otvaraju prostor za participaciju i podižu vidljivost kulturnog nasleđa. Izdvajaju se konkretne prakse komunikacije muzeja u Srbiji tokom pandemije kovid 19, kada je virtuelna prisutnost postala zamena za fizičku, a brojne institucije improvizovale i eksperimentisale sa video-sadržajima i kampanjama na mrežama. Posebno je naglašena važnost vizuelnog narativa, haštaga, digitalne estetike i ritma objava, uz analizu primera uspešnih kampanja domaćih muzeja. Autorke prepoznaju i izazove poput nedostatka stručnog kadra za vođenje naloga, konflikta institucionalnog glasa i dinamike mreže, ali i potrebu za strategijom i dugoročnim pristupom digitalnoj komunikaciji.

U petom poglavlju pod nazivom *Odnosi s javnošću u muzejima* prikazan je sintetički pregled uloge, metoda i izazova odnosa s javnošću (PR) u savremenom muzejskom kontekstu. Autorke definišu odnose s javnošću kao strateški komunikacioni proces koji omogućava muzejima da grade, održavaju i unapređuju svoju vidljivost, kredibilitet i reputaciju u široj društvenoj zajednici. Poglavlje počinje istorijskim pregledom razvoja PR funkcije u kulturnim institucijama, ukazujući na to da je do nedavno ova oblast bila marginalizovana ili shvaćena kao sporedna unutar stručnog muzejskog delovanja. Autorke ističu ključne instrumente PR-a u muzejima: saopštenja za javnost, konferencije, medijske nastupe, kontakt s novinarima, produkciju publikacija i promotivnog materijala, kao i odnos prema kriznim situacijama. Poseban akcenat stavljen je na integraciju tradicionalnih i digitalnih PR

alata – od lokalne štampe do digitalnih biltena i medijskih kampanja na mrežama. Poglavlje donosi i studije slučaja iz muzejske prakse u Srbiji, sa posebnim osvrtom na ulogu PR-a u unapređenju muzejskih programa, učešću u društvenim inicijativama i formiranju javne percepcije muzeja kao društveno angažovanih institucija. Ističe se da uspešni odnosi s javnošću podrazumevaju i poznavanje publike, internu komunikaciju, ali i autentičnost u predstavljanju muzejske misije. Autorke zaključuju da je PR u muzejima daleko više od „marketinga događaja", to je alat za izgradnju poverenja, institucionalne odgovornosti i otvorenog dijaloga s javnošću, što je, u vremenu digitalne fragmentacije i kulturne konkurencije, suštinski značajno za opstanak i razvoj muzejske delatnosti.

Poslednje poglavlje sadrži *Rezime* monografije na srpskom i engleskom jeziku. Ovde autorke ističu da je knjiga namenjena stručnjacima u kulturi zaduženim za komunikaciju i odnose s javnošću, muzejskim edukatorima i pedagozima, upravi muzeja i stručnjacima koji se bave primenom digitalnih tehnologija u prezentaciji nasleđa.

Na kraju knjige *Muzeji i komunikacija s publikom u 21. veku savremene prakse*, autorke prilažu spisak *Literature* i internet izvora potom *Reč recenzenta* kao i *Belešku o autorima*. Preko šezdeset ilustracija (fotografije, crteži i grafikoni) prikazuju konkretne studije muzeja u Srbiji koji su inovativno radili na polju komunikacije sa publikom.

Stručni doprinos ove monografije ogleda se u sistematizaciji i analizi savremenih komunikacionih praksi u muzejskom sektoru Srbije. Autorke pružaju jasne okvire i primere za primenu novih tehnologija, društvenih mreža i PR strategija u funkciji otvaranja muzeja ka publici. Knjiga pruža relevantne uvide za stručno usavršavanje muzejskih radnika u oblasti komunikacija i publike. Osim što osnažuje komunikacionu komponentu muzejskog rada, knjiga *Muzeji i komunikacija s publikom u 21. veku savremene prakse* ima značajan uticaj i na razvoj muzejske pedagogije, jer insistira na publici kao aktivnom učesniku u procesu tumačenja i učenja. Ovaj pristup podržava ideju muzeja kao otvorenog obrazovnog prostora koji se prilagođava različitim profilima posetilaca. Istovremeno, knjiga predstavlja važan doprinos kulturnoj politici u Srbiji, jer podstiče institucije da osmisle dugoročne strategije komunikacije, vidljivosti i društvenog angažmana. Autorke na taj način pomeraju fokus sa tradicionalne, zatvorene uloge muzeja ka savremenom, društveno odgovornom modelu kulturne institucije. Knjiga tako postaje i stručno uporište za formulisanje javnih politika u oblasti kulture i obrazovanja.

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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 prospekciji; 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 (saopštenja), 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 pomoćnom uredniku 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 ***Arheologija 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 pomoćnom uredniku 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.

U slučaju da je poslati rukopis rezultat naučnoistraživačkog projekta ili da je, u prethodnoj verziji, bio izložen na skupu u vidu usmenog saopštenja (pod istim ili sličnim naslovom), detaljniji podaci o projektu, konferenciji i slično, navode se u odeljku ispred prve fusnote rukopisa, koji treba označiti zvezdicom. Rukopis koji je već objavljen u nekom časopisu ne može biti preštampan u časopisu ***Arheologija i prirodne nauke***.

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Sadržaj rada

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 (a) 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.

Autori snose svu odgovornost za sadržaj rukopisa i dužni su da pribave sve potrebne saglasnosti za objavljivanje sadržaja. Autori snose svu odgovornost i za sadržaj istraživačkih podataka i priloga i garantuju da su u procesu sakupljanja, obrade i objavljivanja podataka poštovali važeće propise, etičke standarde, autorska prava trećih lica, kao i druga prava.

Autori koji žele da u rukopis uključe ilustracije, tabele ili druge materijale koji su već negde objavljeni dužni su da za to pribave saglasnost nosilaca autorskih prava. Materijal za koji takvi dokazi nisu dostavljeni smatraće se originalnim delom autora.

Autorstvo

Autori su dužni da kao autore navedu samo ona lica koja su značajno doprinela sadržaju rukopisa, odnosno dužni su da sva lica koja su značajno doprinela sadržaju rukopisa navedu kao autore. Ako su u bitnim aspektima istraživačkog projekta i pripreme rukopisa učestvovala i druga lica koja nisu autori, njihov doprinos treba pomenuti u napomeni ili zahvalnici.

U tom smislu, autori bi trebalo da se upoznaju sa kriterijumima autorstva koje je definisao Međunarodni odbor urednika medicinskih časopisa (International Committee of Medical Journal Editors - ICMJE). Kao autor se može navesti samo ono lice koje je:

- znatno doprinelo koncipiranju ili osmišljavanju rada, ili prikupljanju, analizi i interpretaciji podataka; i
- doprinelo pisanju rada, ili kritičkom redigovanju njegovog naučnog sadržaja; i
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- dalo svoju saglasnost da bude navedeno kao autor i saglasilo se sa spiskom autora.

Prilikom navođenja doprinosa autora mora se koristiti CRediT taksonomija.

Tokom recenzentskog postupka dodavanje novih autora i izostavljanje onih koji su već navedeni dozvoljeno je samo u izuzetnim slučajevima, pod uslovom da je redakciji i izdavaču dostavljeno detaljno obrazloženje zašto je to neophodno. Navođenje imena lica čiji doprinos ne zadovoljava kriterijume autorstva (poklonjeno i počasno autorstvo, kao i navođenje tzv. autora iz senke) smatraće se kršenjem etičkih normi.

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Autori su dužni da ispravno citiraju izvore koji su bitno uticali na sadržaj istraživanja i rukopisa. Informacije koje su dobili u privatnom razgovoru ili korespondenciji sa trećim licima, prilikom recenziranja prijava projekata ili rukopisa i slično, ne smeju se koristiti bez izričite pisane dozvole izvora.

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Plagiranje, odnosno preuzimanje tuđih ideja, reči ili drugih oblika kreativnog izraza i predstavljanje kao svojih, predstavlja grubo kršenje naučne i izdavačke etike. Plagiranje može da uključuje i kršenje autorskih prava, što je zakonom kažnjivo.

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- kopiranje slika ili tabela iz tuđih rukopisa bez pravilnog navođenja izvora i/ili bez dozvole autora ili nosilaca autorskih prava.

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Ako se ustanovi da je rukopis koji je objavljen u časopisu plagijat, isti će biti povučen u skladu sa procedurom opisanom pod *Povlačenje već objavljenih rukopisa*, a autorima će biti privremeno zabranjeno da objavljuju u časopisu ***Arheologija i prirodne nauke***.

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Autoplagiranje, odnosno preuzimanje već objavljenih sopstvenih ideja, reči ili drugih oblika kreativnog izraza bez adekvatnog ukazivanja na izvor, predstavlja grubo kršenje naučne i izdavačke etike. Autoplagiranje može da uključuje i kršenje autorskih prava, što je zakonom kažnjivo.

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obeležavanje kopiranih fragmenata (na primer, korišćenjem navodnika);
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Ako se ustanovi da je rukopis koji je objavljen u časopisu autoplagijat, isti će biti povučen u skladu sa procedurom opisanom pod *Povlačenje već objavljenih rukopisa*, a autorima će biti privremeno zabranjeno da objavljuju u časopisu ***Arheologija i prirodne nauke***.

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- 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 pojedinačnog 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 discipini 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 poslati 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 spolj-nim 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 predočeni 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/recenzenta;
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- 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 podacima 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.

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Izuzeci: Javno objavljivanje podataka nije uvek izvodljivo. U sledećim slučajevima podaci koji potkrepljuju rezulate 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, nevlasničkom 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).

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 prospekciji; 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 (saopštenja), 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.
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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/cpso/roman.html), npr:

Citat u tekstu: (Поповић 1988: 67)

Način navođenja u bibliografiji:

Поповић, И. 1988
Античко оруђе од гвожђа у Србији,

Београд: Народни музеј.
(Popović, I. 1988

Antičko oruđe od gvožđa u Srbiji, Beograd: Narodni muzej).

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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 Meziji, 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.

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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
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2. Autorizovane knjige sa pridodatim imenom urednika

u tekstu: (Jeremić 2009: 40)
u Literaturi:
Jeremić, G. 2009
Saldum, Roman and Early Byzantine Fortification, Perić, S. (ed.), Cahiers des Portes de Fer, Monographies 6, Belgrade: Institute of Archaeology.

3. Priređene 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
C*lassical 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; Popović 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 Improbale, 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,* Крунић, С. (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*, Stone, S. (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, Beograd: 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)*, Prezime, Inicijal imena. (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 Панониje*, Стојанов, М. (ур.), Нови Сад: Матица српска, 25–44.

Potrebno je 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), Лазић, М. (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-Хаџи-Пешић, М. 2001
Налази хабанске и постхабанске керамике у Србији, *Годишњак града Београда* 47–48 (2000-2001): 107–121.

- Za časopise čiji su nazivi slični, iza naziva časopisa u zagradi treba navesti mesto 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* se, zavisno od godine 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 se godina izlaženja i godina za koju časopis izlazi razlikuju, navesti i drugu godinu u zagradi:
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*, Лазић, М. (ур.), Бор: Музеј рударства и металургије; Београд: Филозофски факултет.

IV ČLANCI IZ ELEKTRONSKIH ČASOPISA

Članci preuzeti sa interneta iz elektronskih časopisa navode se na isti način kao štampani članci, ali se na kraju dodaje puna veb adresa sa http://...

V DOKTORSKE DISERTACIJE I MAGISTARSKE TEZE

Umesto mesta izdanja i izdavača navodi se naziv fakulteta/univerziteta gde je teza odbranjena.
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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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).

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 acta, 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 apropriate for indexing and web-searching. If there are no such words withing 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 about 200 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 apropriate 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, around 1/10 of the manuscript’s main text size, as well as the title of the manuscript. 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/cpso/roman.html), for example:

Quotation within a footnote: (Поповић 1988: 67)

In the list of references: **Поповић, И. 1988**

Античко оруђе од гвожђа 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 reccomendation 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 Meziji, 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 abbrevation ***et al.*** is applied. The abbrevation ***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, Perić, S. (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
C*lassical 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; Popović 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.
Popović, 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,* Крунић, С. (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*, Stone , S. (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)*, Surname, Name's initial. (ed.), Place of publishing:

Publisher, page numbers.

Vasić, M. 2006.

Stibadium in Romuliana and Mediana, in: *Felix Romvliana 50 Years of Archaeological Excavations*, Vasić, M**.** (ed.), October, 27-29 2003, Zaječar, Serbia, Belgrade, Zaječar: Institute of Archaeology, Committee on Archaeology of Serbian Academy of Sciences and Arts, and National Museum Zaječar, 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 [novog reda] *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

Urbanism 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 referrences 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 assistant editor 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. Shold 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 necessarry.

* * *

For additional explanations, please contact the assistant editor 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.

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(*ARCHAEOLOGY AND SCIENCE*)

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