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First insights into the Mesolithic settlement of Southern Serbia: excavation of the Pešterija Cave in the Ponišavlje Region

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ABSTRACT - Despite extensive research and excavations across the central Balkans, Early Holocene sites have so far been documented only in the Iron Gates region – for which there are several possible explanations. Some scholars argue that the apparent lack of Mesolithic sites is due to inadequate research efforts in the region, while others suggest that the ecological conditions in the central Balkans during the Early Holocene may not have been favourable to the subsistence of hunter-gatherer communities. Contrary to previous beliefs, recent investigations of caves in eastern Serbia have revealed that humans inhabited the region during the Mesolithic. Traces of settlement of Mesolithic groups, dating back to the 7th millennium cal BC and employing comparable technology and economic practices to Mesolithic communities in other parts of the Balkan Peninsula, have been documented at the Pešterija Cave, situated south of Pirot in southeastern Serbia. The fact that the site is located relatively close to the oldest Neolithic sites in the Iron Gates and northwest Bulgaria, and is potentially contemporaneous with them, offers a completely new perspective on the transition from the Mesolithic to the Neolithic in this part of the Balkans.

KEY WORDS – Mesolithic; Balkans; caves; Nišava; lithic assemblages; faunal remains

Prvi vpogled v mezolitsko poselitev južne Srbije: izkopavanje jame Pešterija v Ponišavlju

IZVLEČEK – Zgodnje holocenska najdišča na osrednjem Balkanu so bila kljub obsežnim raziskavam in izkopavanjem doslej dokumentirana le na območju Železnih vrat – za kar obstaja več možnih razlag. Nekateri raziskovalci trdijo, da je očitno pomanjkanje mezolitskih najdišč posledica neustreznih raziskovalnih prizadevanj v regiji, drugi menijo, da ekološke razmere na osrednjem Balkanu v zgodnjem holocenu morda niso bile naklonjene preživetju skupnosti lovcev in nabiralcev. V nasprotju s prejšnjimi prepričanji so nedavne raziskave jam v vzhodni Srbiji pokazale, da so ljudje to regijo naselili v mezolitiku. V jami Pešterija, ki se nahaja južno od Pirota v jugovzhodni Srbiji, so bili dokumentirani sledovi poselitve mezolitskih skupin, ki segajo v 7. tisočletje pr.n. št. Dejstvo, da so najdišča relativno blizu najstarejšim neolitskim najdiščem v Železnih vratih in v severozahodni Bolgariji ter da so jim potencialno sočasna, ponujata popolnoma nov pogled na prehod mezolitika v neolitik na tem delu Balkana.

KLJUČNE BESEDE – mezolitik; Balkan; jame; Nišava; kameni zbiri; živalski ostanki

Introduction

More than half a century has passed since the discovery of Mesolithic sites in the Iron Gates region, revealing traces of elaborate architecture, formal burial grounds, artistic artefacts (including those unearthed at Lepenski Vir), as well as numerous tools and faunal remains. At the time of discovery, it was hypothesized that the Lepenski Vir culture encompassed a vast territory across the Middle and Lower Danube Basin (*Srejović 1979*). Similar to the discoveries in the Iron Gates, the research conducted in the Adriatic, Ionian, and Aegean zones during the 1980s revealed a plethora of rich and multi-layered Epipalaeolithic and Mesolithic sites. The number of these sites significantly increased following the investigations in Istria and northern and central Dalmatia (*Komšo 2006*), and further south in the Greek islands during the 1990s (*Kaczanowska, Kozłowski 2014*). All of this indicates that the Balkan Peninsula as a whole was densely populated during the Mesolithic period (Fig. 1).

However, subsequent research following the investigations in the Iron Gates did not confirm these expectations for the interior of the Balkans. In the interior of Slovenia, the Mesolithic period has only been documented at the Zalog pri Verdu (*Gaspari 2006*) and Breg pri Škofljici (*Turk 2022*) sites, while in the interior of Croatia it is only attested in the Zala Cave (*Vukosavljević, Karavanić 2015*). The Mesolithic has been also documented at a few sites in the northern part of Montenegro (e.g., Odmut and Vrbička Cave – *Borić et al. 2019*), as well as at the Kryegjata B and Neziri Cave in Albania (*Runnels et al. 2007; Hauck et al. 2017*). In Bulgaria and North Macedonia, no Mesolithic sites have been conclusively confirmed, while in Bosnia and Herzegovina traces of Mesolithic occupancy have been noted only in the Rastuša Cave (*Jovanović et al. 2014*). A similar situation has been recorded in Serbia. Following intensive surveys of the Iron Gates hinterland, the Mesolithic has only been identified in Radujevac (*Radovanović et al. 2014*). A layer containing fauna (including bones with cut marks) dated to the Early Holocene was confirmed at Bukovac (*Živaljević et al. 2018*), while the Early Holocene age (8th millennium cal BC) has also been confirmed for human and animal remains at several sites in northern Serbia (*Živaljević et al. 2021*).

The apparent paucity of Mesolithic sites in the interior of the Balkans has been subject to numerous discussions, with some authors suggesting that Mesolithic

sites may be buried beneath thick alluvial deposits and therefore remain undetected (*Kotsakis 2001*), others argue that inadequate methods were used in the survey efforts (*Runnels 2003*), or that surveys did not cover areas where Mesolithic settlements could be expected (*Mihailović 2021*). Some have even suggested that the territory of Greece was sparsely populated during the Mesolithic (*Runnels 1995; Perlès 2003*). According to Catherine Perlès (*2003*), Mesolithic settlements where sedentarization occurred should be archaeologically visible, so the fact that they have not been discovered suggests that they may not exist at all.

Maria Gurova and Clive Bonsall (*2014*) proposed a compelling explanation for the absence of the Mesolithic in the Balkans. According to them, during the Early Holocene extensive forest growth made the central Balkans difficult to traverse, suggesting that favourable conditions for settlement existed only in the forest margins – in coastal areas and plateaus – if these areas were exploited seasonally, and that the communication between Mesolithic groups could have only occurred along river valleys. The authors argued that, since the region lacks waterways and glacial lakes, even this area could not have been densely populated. Although we concur with the majority of Gurova and Bonsall's (*2014*) conclusions, we disagree with the notion that the central Balkans lack waterways, as substantial portions of the region are defined by the valleys of major rivers such as the Danube, Sava, Morava, and Nišava, which likely provided favourable conditions for human settlement. Hence, we postulated that Mesolithic settlements in the valleys of these rivers have probably not been discovered because, unlike the Iron Gates, the lowest river terraces and profiles have not been systematically surveyed (*Mihailović 2021*).

In considering the potential distribution and settlement patterns of Mesolithic groups over time, the question has arisen as to how frequently hunter-gatherer communities, if concentrated along river courses, visited the upland mountainous hinterlands. For this reason, particularly in the central Balkans, our research has been focused on surveys and exploratory excavations of cave sites located on the outskirts of river valleys and places where the valleys are widest. Despite this effort, we did not detect Mesolithic remains in most of the caves we explored until 2022 when we discovered Mesolithic material in Pešterija, located in the far southeast of Serbia. The discovery of Pešterija necessitates a re-evaluation of hypotheses regarding the settlement patterns of the interior of the Balkans dur-

ing the Late Mesolithic, and the current assumptions about cultural and social interactions between Mesolithic and Neolithic communities during the period of Neolithisation in the central Balkans.

Previous investigations of cave sites in south-eastern Serbia

For several reasons, research on the Palaeolithic and Mesolithic in the central Balkans over the past few decades has primarily focused on eastern Serbia. This area encompasses the Iron Gates region at the extreme north, making it crucial to ascertain whether Meso-

lithic sites also appear in the hinterland of the Iron Gates. In addition, eastern Serbia is bordered by major natural communication routes which historically connected the southern Balkans and the Black Sea region with central and western Europe, making it significant for the study of the process of Neolithisation. Finally, eastern Serbia is characterized by a highly developed karst relief with numerous caves and natural shelters.

Systematic surveys of Palaeolithic and Mesolithic sites in the central Balkans have covered the entire territory of eastern Serbia since 2002, spanning from the Iron

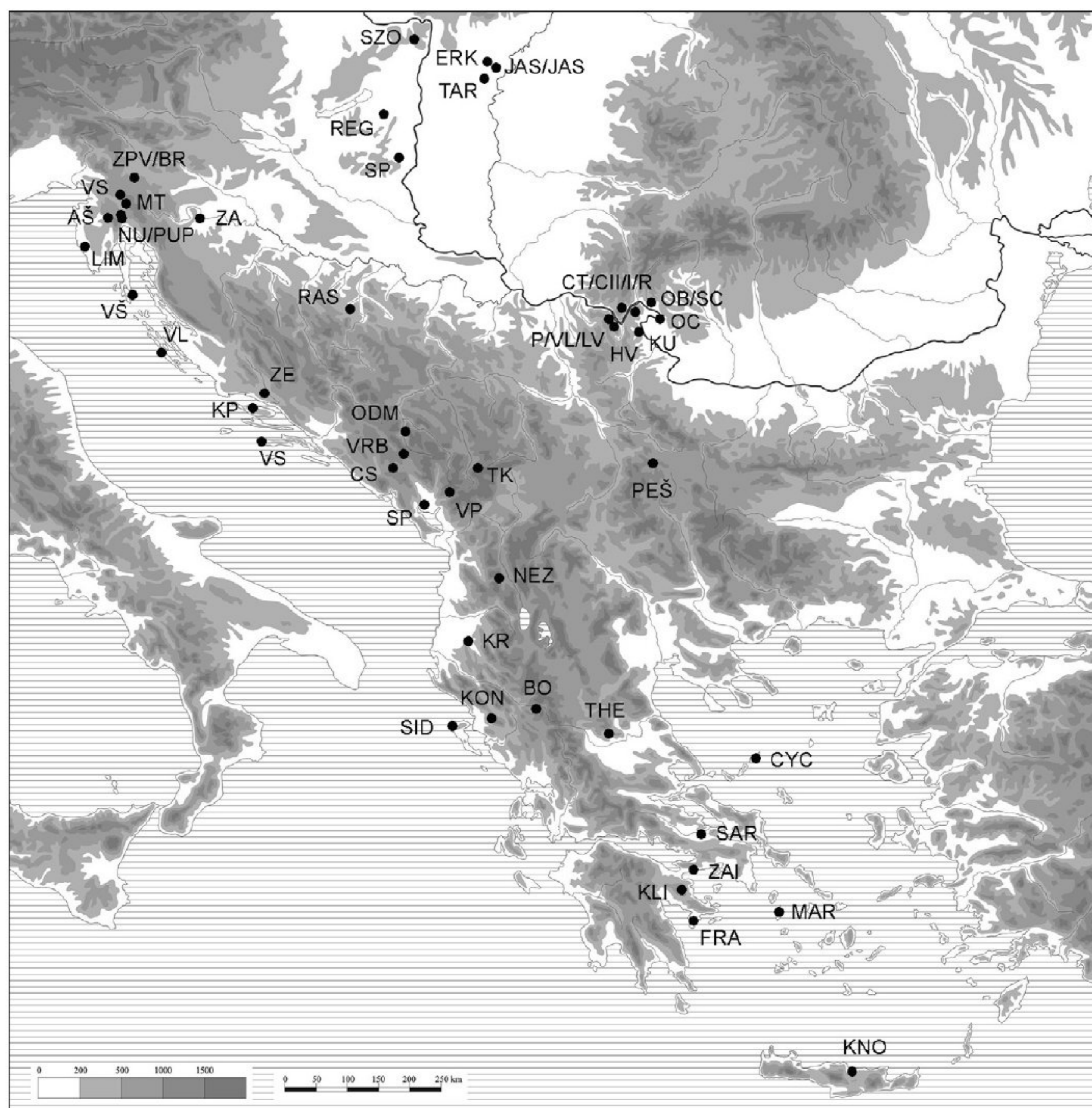


Fig. 1. Mesolithic sites in Southeast Europe: Zalog pri Verdu/Breg (ZPV/BR); Viktorjev Spodmol (VS); Mala Triglavica (MT); Abri Šebrn (AŠ); Nugljanska and Pupičina Cave (NU/PUP); Lim 001 (LIM); Zala (ZA); Vela Špilja (VŠ); Rastuša Cave (RAS); Vlakno (VL); Kopačina Pećina (KP); Zemunica (ZE); Vela Spila (VS); Sződliget (SZO); Regöly (REG); Szekszárd Palánk (SP); Erk (ERK); Jászberény/Jásztelek (JAS/JAS); Tarnaörs (TAR); Odmut (ODM); Vrbička Pećina (VRB); Crvena Stijena (CS); Seocka Pećina (SP); Vruća Pećina (VP); Trebački Krš (TK); Neziri Cave (NEZ); Kryegjata B (KR); Konispol Cave (KON); Sidari (SID); Boila (BO); Theopetra Cave (THE); Cyclope (CYC); Sarakenos Cave (SAR); Zaimis (ZAI); Klissoura Cave 1 (KLI); Franchthi Cave (FRA); Maroulas (MAR); Knossos (KNO); Cuina Turcului/Climente II/Icona/Razvrata (CT/CII/I/R); Ostrovul Banului/Schela Cladovei (OB/SC); Ostrovul Corbului (OC); Padina/Vlasac/Lepenski Vir (P/VL/LV); Hajdučka vodenica (HV); Kula (KU); Pešterija (PEŠ).

Gates hinterland in the north, to the southern slopes of the Carpatho-Balkanides in the south, and from the valleys of the Great and South Morava rivers in the west to the Stara Planina mountain. In the east, encompassing various topographic and ecological zones. The surveys were conducted as part of several international projects lead by the Faculty of Philosophy (University of Belgrade, Serbia) in collaboration with multiple international institutions, including the University of Winnipeg, the University of Arizona in Tucson, the University of Kansas in Lawrence, and the Max Planck Institute for Evolutionary Anthropology in Leipzig.

During reconnaissance, over 100 potential cave sites were identified, presumed to have provided favourable conditions for settlement in the past. Around 30 of these sites were subjected to exploratory excavations, revealing predominantly pre-Neolithic materials. Lower and Middle Palaeolithic remains – including hominin fossils – have been mainly documented in southern Serbia (Roksandic et al. 2011; 2022; Radović et al. 2019; Lindal et al. 2020; Mihailović et al. 2022), Aurignacian materials were found exclusively in the northern part of the country (Mihailović et al. 2011), while Gravettian artefacts have been found throughout the surveyed territory. These studies have shown that the central Balkans were inhabited during all phases of the Middle Palaeolithic (Mihailović, Mihailović 2023),

that anatomically modern humans settled the interior of the continent from the direction of the Danube (Mihailović 2020), and that the Balkans likely served as a refuge for Gravettian communities at the onset of the Last Glacial Maximum (LGM) (Stiner et al. 2022). However, our research provided little evidence of settlement in this area during the late Upper Palaeolithic and Mesolithic periods. Located in the far south of eastern Serbia, the Nišava River basin represents a notable exception, where, alongside Gravettian sites dated to the period before the LGM (*i.e.* Meča Dupka, Pešturina, Potpeč, Alex et al. 2019; Plavšić, Popović 2019), sites from the peak of the LGM were also discovered (such as Velika Vranovica – lower cave, and Pećina kod Steine, Kuhn et al. 2014; Mihailović et al. 2017), as well as the aforementioned remains dated to the Mesolithic period (Pešterija).

Physiographic, climatic, and ecological characteristics of the Ponišavlje region

The Nišava River basin covers an area of 2971.5km² (Manojlović 2019) and extends from southeast to northwest over a length of 218km, ranging from lowland (plain) to high mountainous terrain (>1500 m a.s.l.) (Fig. 2). The region belongs to the long Carpatho-Balkanides arch, which extends through the southeastern part of Europe. A significant geological feature of

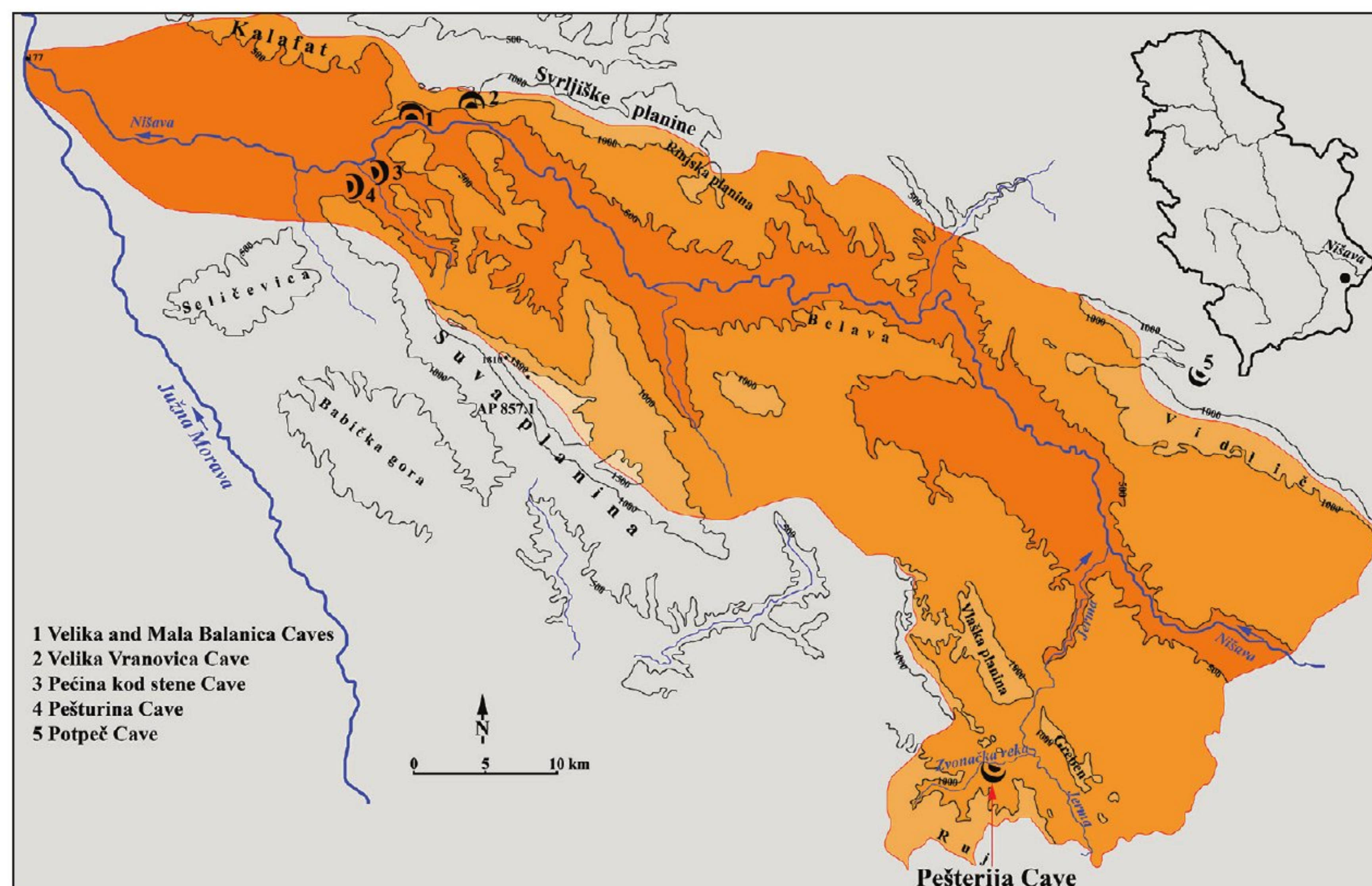


Fig. 2. Distribution of Palaeolithic and Mesolithic sites in the Ponišavlje region.

this region is the prominence of carbonate rocks, which serve as the basis for forming numerous caves (Djurović 1998; 2018; 2022). Limestone is consistently found in the peripheral areas of the region – including Suva Planina, Belava, Vlaška Planina, Kalafat, Svrlijig Mt., and Vidlič – while its presence in other areas is often sporadic. The highest mean annual air temperatures are typical for the valley bottom of the Nišava River, where temperatures gradually decrease from 11.7°C in the northwest to 9.9°C in the southeast. Instrumental measurements and statistical calculations have revealed a significant decrease in air temperature from the valley bottom towards the peripheral mountainous areas in the southwest and northeast, where the annual difference ranges from 6 to 8°C (Milovanović et al. 2022). The annual amount of precipitation in the valley increases slightly by about 50mm from the lowest northwest parts to the highest southeast parts, ranging from 592 to 642mm. The peripheral mountainous areas receive a higher annual amount of precipitation, ranging from around 800 to about 1000mm for the highest mountain areas (Manojlović 2019; Milovanović et al. 2022).

Within the Nišava basin, karst terrain spans an area of 659.2km², constituting 22.1% of the basin. It is distributed across several elevation zones (Manojlović 2019). Its largest extent is found in the low mountainous area between 500 and 1000m a.s.l., covering 64.4% of this elevation zone or 424.7km². Karst is less prevalent in the mid-mountainous zone (1000–1500 m a.s.l.), where it occupies 23.3% or 153.3km². It is least represented in the low-hilly area below 500m a.s.l., covering 9.7% of the zone's surface area, or 63.7km². Karst terrain is minimally present in the high mountainous area above 1500m a.s.l., covering only 2.7% or 17.8km². In the southern part of Upper Ponišavlje, in the valley of the Zvonačka reka River, within the watershed of the Jerma River, a left tributary of the Nišava River, several smaller karst outcrops are located, formed in Triassic and Jurassic limestone. The largest karst outcrop is in the area of Asenovo Kale, situated south of the Zvonačka River (right valley side). The northern part of the karst outcrop is composed of Jurassic limestone, which is separated by faults from the southern part consisting of Jurassic limestone with chert nodules (Oxford, Kimmeridgian) (Anđelković et al. 1964–1968). Within this karst outcrop, there are four caves arranged in a stepped manner, ranging from 7 to 55m in length. Apart from the lowest cave – in which there is a captured spring – the others have no hydrological function. Among this group of caves is Pešterija.

Positioning, appearance, exploration, and stratigraphy of Pešterija

The Pešterija Cave is situated in the southern part of the region discussed here, within the Zvonačka reka River valley (Fig. 3), in the basin of the Jerma River, a left tributary of the Nišava River (N 42.55819, E 22.35951). Pešterija is located on the right side of the valley, in the highest part of the short Cedilka canyon, 100m above the Zvonačka reka riverbed (Fig. 4), at 715 m a.s.l. The cave is set within Jurassic limestones which extend on both sides of the valley. The entrance is 13.5m wide and faces north, while the depth of the cave is approximately 15m (Fig. 5). The cave was identified as a potential archaeological site in 2011, with exploratory excavations conducted in 2022 and 2023. The excavations were organized on a grid system, delineated by squares and quadrants. Fragments of rocks, artefacts, and animal bones larger than 2cm were recorded *in situ*. The excavated sediment was dry-sieved using 3mm screens.

Upon arrival at the site in 2022, it was noted that geological layers were preserved only in the northern part of the cave, at the boundary of the sheltered area. This is due to the presence of a spring in the back of the cave, which has washed away the sediment from the southern part of the site. There was a pit – approximately 2m in diameter – excavated by the treasure hunters at the cave entrance, to the rocky base at a depth of 1.3m, revealing layers containing wheel-thrown pottery from historical periods. During the initial campaign, the pit profiles were aligned with the grid to potentially identify even older artefacts within the visible layers at the base of the profile (Fig. 6).

During the profile correction, geological layer 2 yielded a significant number of archaeological finds and faunal remains dating back to the historical periods, while layer 3 contained small, chipped stone artefacts (including one backed bladelet) and sporadic faunal remains (Fig. 7). Notably, the taxa exclusive to the Pleistocene were not identified among the faunal remains in this layer. Animal bones and several non-diagnostic artefacts were found in layer 4, characterized by coarse limestone debris and partial cementation. In contrast, only animal bones were found in layer 5, which consisted of clayey sediment. The initial observations were confirmed during the excavations in the subsequent 2023 field season. During this season, the excavation area was expanded towards the north and west, investigating a surface area of 5m² to a depth of

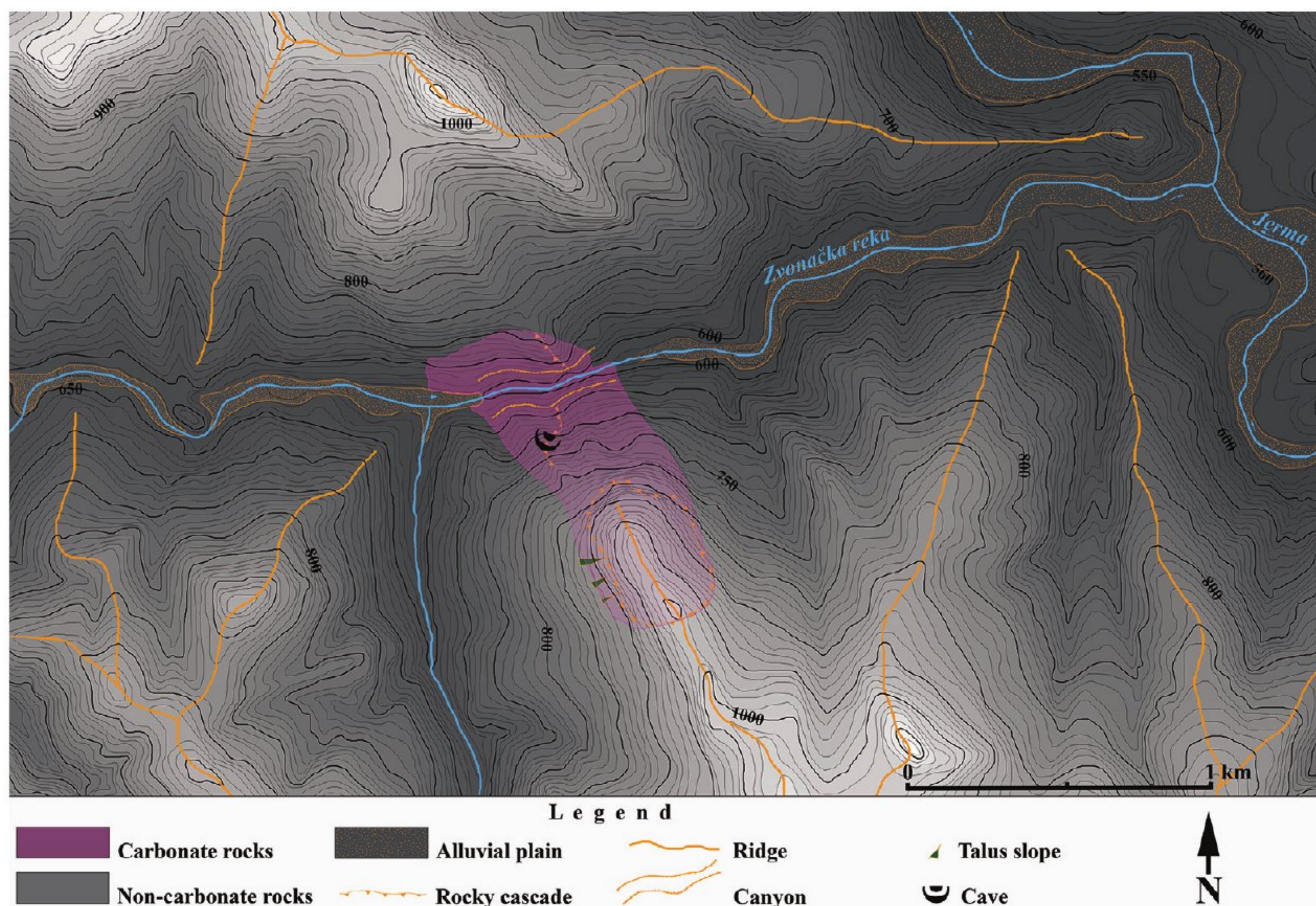


Fig. 3. Geomorphological map of the area around Pešterija Cave.

approximately 1m, reaching layer 4. At this stage of research, the age of the deepest layer at the site remains uncertain, primarily due to the absence of diagnostic artefacts.

Given the initial indications that layer 3 probably dated back to the late Upper Palaeolithic or Mesolithic, three bone samples from this layer were subjected to radiocarbon dating in the Ottawa laboratory in 2023 (Tab. 1). The bones were pretreated with the ultrafiltration step following the precise procedures outlined in Carley A. Crann *et al.* (2017). The first sample (PesP-2022-1) yielded an age corresponding to the early 6th millennium cal BC, the second sample (PesP-2022-2) provided an age corresponding to the middle of the 7th

millennium cal BC, and the third sample (PesP-2022-3) indicated an age at the end of the 8th millennium cal BC. The samples were taken from the middle and lower parts of layer 3, where there were no intrusions (*e.g.*, pottery fragments) from the upper layers. In layer 3, no identifiable strata have been observed that could be linked to individual dated samples, which could account for the differing dates obtained for them.

Faunal remains

The context and taphonomy

The analysed faunal remains were collected from geological layers 3–5. The sample consists of 1358 identified specimens (NISP), with the vast majority (82.1%) originating from layer 3. The mammal bone assemblage exhibits a high degree of fragmentation; there were no complete bone specimens (except for small mammal bones), and there was only a small number of complete epiphyses. Fragments less than 2cm prevail

Lab ID	Submitter ID	Material	Collagen yield %	¹⁴ C yr BP	±	cal BC
UOC-21631	PesP-2022-1	Animal bone	7.4	6993	24	5980–5946 (19.0%) 5922–5796 (76.5%)
UOC-21632	PesP-2022-2	Animal bone	6.1	7428	24	6380–6235 (95.4%)
UOC-21633	PesP-2022-3	Animal bone	3.9	8210	25	7322–7132 (84.3%) 7110–7078 (11.2%)

Tab. 1. Results of radiocarbon dating of layer 3 of Pešterija Cave. Calibration is performed using OxCal v4.4 (Bronk Ramsey 2021) and the IntCal20 calibration curve (Reimer *et al.* 2020).

($n = 862$, *i.e.* 69.1%), and no fragments were longer than 10cm.

A significant number of mammal bone specimens were burnt ($n = 498$, *i.e.* 39.9%), however, it should be noted that the traces of burning were often difficult to discern from mineral staining. The bones exhibited varying degrees of exposure to fire: the majority were (partly) burnt (67.1%), but extensively carbonized and calcined specimens also occurred (Fig. 8). One bone fragment from layer 3 (square N19/a) displayed light bluish-grey colouration, indicative of long and intense heating.

A small number of specimens ($n = 5$) bore visible gnawing marks. One red deer first phalanx was gnawed by a rodent, whereas four specimens – a ruminant first phalanx, a chamois first phalanx, a marten humerus fragment and a mammal rib fragment – bore carnivore teeth marks. Another chamois first phalanx and a ruminant third phalanx were digested. Other taphonomic modifications included root etching and/or microbial activity, visible on three bone specimens. Anthropogenic modifications will be further discussed below.

Taxonomic composition

The faunal sample from Pešterija exhibits significant diversity, encompassing the remains of large, medium-sized, and small mammals, micromammals (*i.e.* those weighing less than 1kg), birds, amphibians, fish, and molluscs (Tab. 2). The vast majority originate from large, medium-sized and small mammals (1249 specimens, *i.e.* 92%). However, only 42 specimens (3.4% of the mammal bone assemblage) could be identified to the species, genus, family or order level, due to the high degree of bone fragmentation.

In the case of large and medium-sized mammals, the remains of ruminants – mainly red deer (*Cervus elaphus*) and chamois (*Rupicapra rupicapra*) – were more numerous than carnivores. Whereas red deer was ubiquitous and commonly hunted in the Pleistocene and Holocene, the chamois was relatively rare during the Pleistocene, and its remains were documented at a limited number of mountain sites, usually in modest numbers. It was present in the Iron Gates during the Early Holocene, as evidenced by its occurrence in faunal assemblages



Fig. 4. View of the Cedilka canyon along the Zvončka reka River (photo Dušan Mihailović).

from several Mesolithic sites in this area (Padina, Lepenski Vir, Vlasac, Hajdučka Vodenica and Icoana) (Bolumey 1973; Bökönyi 1975; 1978; Clason 1980; Borić, Dimitrijević 2005; Dimitrijević 2008; Greenfield 2008; Bălăsescu et al. 2021). Its presence was also con-



Fig. 5. Pešterija – view from inside the cave (photo Dušan Mihailović).

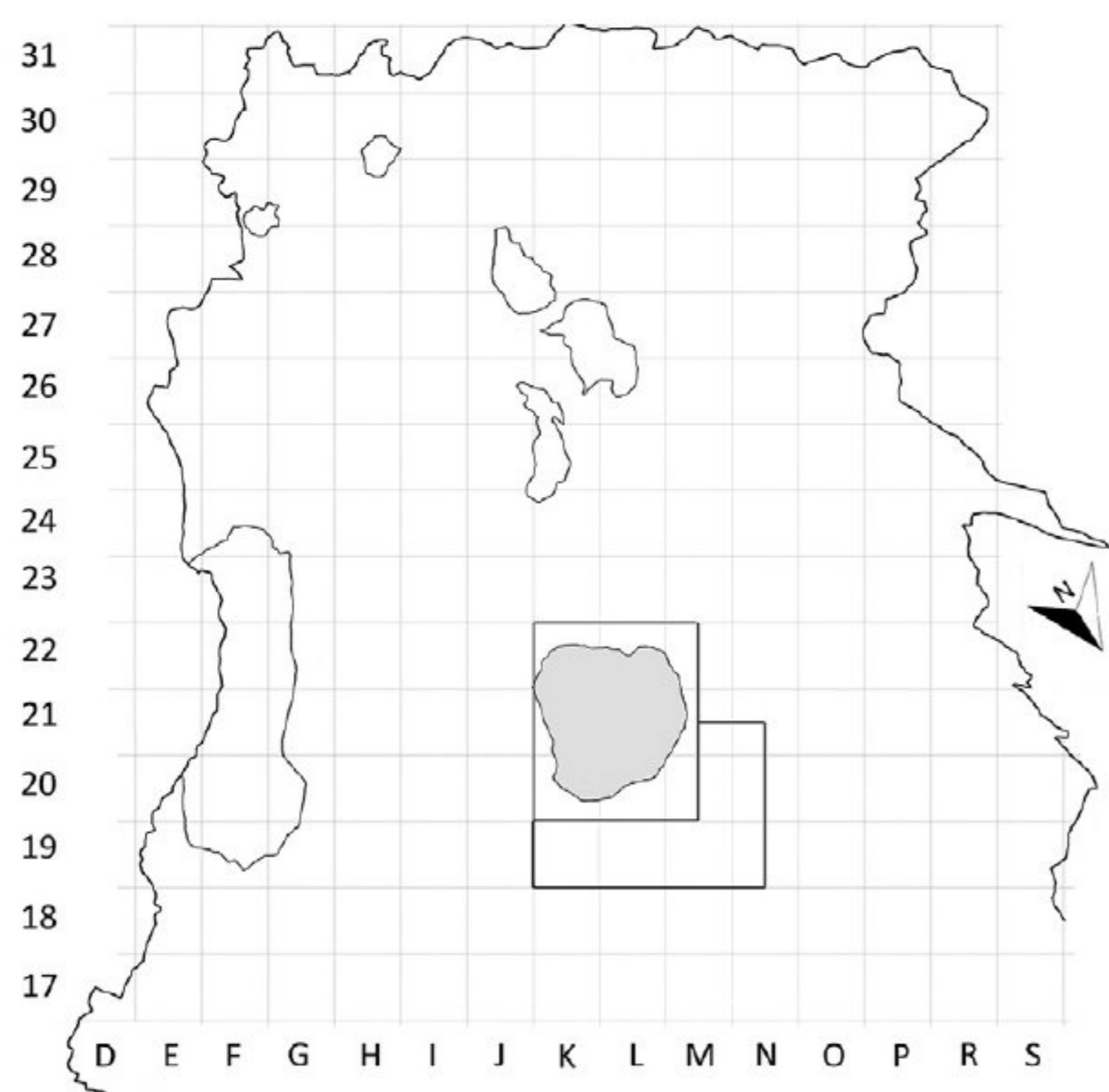


Fig. 6. Pešterija Cave ground plan (drawing Sofija Dragosavac).

firmed in Montenegro – in Mesolithic layers at Seocka pećina (Vander Linden et al. 2014; 2015) and Mesolithic and Neolithic layers at the Odmuť rock shelter (Borić et al. 2019), as well as at the Early Neolithic site of Obre in Bosnia and Herzegovina, and the Late Neolithic site of Sitagroi in Northeastern Greece (Bökönyi 1978). From the Middle Holocene, chamois became largely extirpated in the region.

At Pešterija, chamois remains primarily originated from geological layer 3 (eight specimens), and only one specimen was found in layer 5. The specimens include deciduous teeth (a left incisor and a left lower second premolar), a permanent right lower second molar, mandible fragments, and fragments of a left radius, metatarsal bone, and three first phalanges, originating from a minimum of two individuals. The metatarsal fragment from layer 3 (square N19/a) bore transverse scraping marks and an overlying long cut mark, inflicted by a chipped stone tool. As previously mentioned, one of the phalanges (from layer 5, square L19/c) was gnawed by a carnivore, and the other (from layer 3, square M21/a) shows digestive etching.

Red deer was also represented by a minimum of two individuals, and all skeletal elements attributed to this species ($n = 13$) originated from layer 3. These include an antler fragment, a deciduous upper right third premolar, a fragment of an upper right molar bud, a right and left first incisor, a molar fragment, a hyoid bone, two mandible fragments, a lumbar vertebra, a left radius fragment, a metapodial bone fragment, and a fragmented first phalanx. In addition, an upper right canine originated from layer 3/4. Based on the heavily worn deciduous premolar (from square M19/a), it can be suggested that the animal was killed at the age of 27 months, *i.e.* between the end of September and the beginning of October. The same age at death and ultimately the same hunting season were determin-

	TAXON	NISP	MNI
Mammals (large, medium-sized and small)	hare (<i>Lepus europaeus</i>)	2	1
	fox (<i>Vulpes vulpes</i>)	1	1
	marten (<i>Martes</i> sp.)	2	1
	indeterminate carnivores (Carnivora indet.)	1	/
	red deer (<i>Cervus elaphus</i>)	14	2
	roe deer (<i>Capreolus capreolus</i>)	2	1
	chamois (<i>Rupicapra rupicapra</i>)	9	2
	indeterminate ruminants (Ruminantia indet.)	9	/
	indeterminate mammals (Mammalia indet.)	1207	/
	TOTAL	1249	8
Micromammals	mole (<i>Talpa europaea</i>)	1	1
	wood mouse (<i>Apodemus</i> cf. <i>sylvaticus</i>)	1	1
	indeterminate murids (Muridae indet.)	1	1
	indeterminate squirrels (Sciuridae indet.)	1	1
	indeterminate micromammals (Micromammalia indet.)	24	/
	TOTAL	28	4
Birds	bird of prey	2	1
	indeterminate birds (Aves indet.)	27	/
	TOTAL	29	1
Amphibians	fire salamander (<i>Salamandra salamandra</i>)	1	1
	marsh frog (<i>Pelophylax</i> cf. <i>ridibundus</i>)	2	1
	indeterminate frog (Anura indet.)	2	1
	TOTAL	5	4
Fish	vyrezub (<i>Rutilus frisii</i>)	1	1
	TOTAL	1	1
Vertebrates	indeterminate vertebrates (Vertebrata indet.)	19	/
	TOTAL	19	/
Molluscs	Roman snail (<i>Helix pomatia</i>)	4	1
	indeterminate gastropods (Gastropoda indet.)	20	8
	freshwater mussel (<i>Unio</i> sp.)	2	1
	indeterminate molluscs (Mollusca indet.)	1	1
	TOTAL	27	11

Tab. 2. The taxonomic composition of the faunal assemblage from Pešterija Cave.

ed in the case of a red deer skull deposited on the floor of Building 28 at the site of Lepenski Vir (Dimitrijević 2000; 2008; Dimitrijević et al. 2016; cf. Brown, Chapman 1991).

Apart from red deer and chamois, the remains of another ruminant species – roe deer (*Capreolus capreolus*) – were also present in the faunal sample, albeit in modest numbers. Two elements were attributed to roe deer – an antler tip and a longitudinally split first phalanx and an antler tip, found in geological layers 3 and 3/4, respectively. A total of 11 specimens from layers 3 and 4 were identified only to the order level, categorized as ruminants (Ruminantia indet.).

The sample contained remains of at least two species of carnivore – fox (*Vulpes vulpes*) and marten (*Martes* sp.) – all of which were discovered in layer 3. The fox was represented by a calcaneus fragment, and the marten by a fragment of the right mandible and a gnawed fragment of the right humerus. In addition, one carnivore left ulna fragment from layer 3 most likely belonged to a canid larger than a fox, which allows the possibility that it originated from a dog (*Canis familiaris*). As previously mentioned, certain bone fragments bore gnawing marks, with punctures corresponding to fox or dog teeth. While there is ample evidence of local dog domestication in the Iron Gates Mesolithic (Bökönyi 1975; 1978; Dimitrijević, Vuković 2012) and long histories of human-canid coexistence in this area (Radovanović 1999; Dimitrijević 2008; Živaljević 2015), in other parts of the Balkans this phenomenon is still poorly understood. There is certainly a possibility that dogs were companion species to the Mesolithic communities in the Ponišavlje region as well, but this hypothesis remains to be tested with future excavations retrieving skeletal elements that can be identified with more certainty.

The faunal sample from Pešterija also yielded small mammal remains, represented by an upper right third premolar fragment and a right fourth metatarsal of a hare (*Lepus europaeus*). The majority of micromammal remains ($n = 24$) consisted of long bones that did not allow for precise taxonomic identification. Only two specimens could be identified at the species level – the left humerus of a mole (*Talpa europaea*), and the left mandible of a wood mouse (*Apodemus* cf. syl-

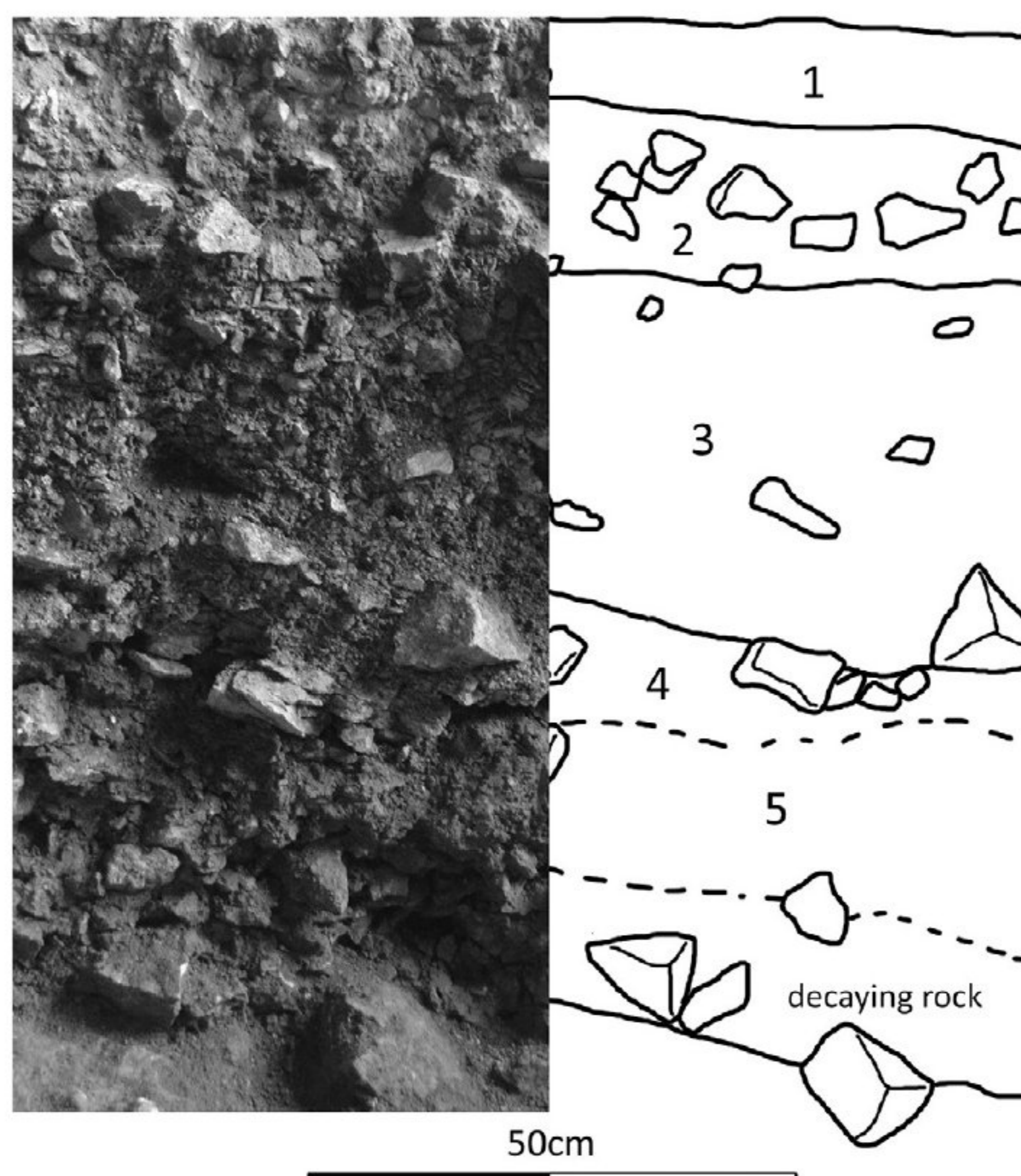


Fig. 7. A part of the western profile within Pešterija Cave (photo and drawing Sofija Dragosavac).

vaticus). In addition, two more specimens could be identified to the family level – a left humerus, most likely of a murid (Muridae indet.), and a right humerus belonging to a member of the squirrel family (Sciuridae indet.). The wood mouse and mole are species which typically inhabit deciduous forests, woodland edges, wet meadows and shrublands. Consequently, the occurrence of their remains at Pešterija is indicative of a relatively humid and moderately warm climate during the time of their accumulation (cf. Popov 2000).

The bird bone assemblage from Pešterija mainly consisted of skeletal elements – coracoid, ribs, vertebrae, long bones, tarsometatarsi, and phalanges ($n = 27$) – that did not allow for more precise taxonomic identification. They mainly derive from small birds, except for a second phalanx found in layer 4 (square L19/c) and an unguis phalanx (talon) found in layer 3 (square M19/a) (Fig. 9.a) which belonged to larger birds of prey. At the Mesolithic site of Vlasac in the Iron Gates, the occurrence of metatarsi and phalanges of white-tailed eagle (*Haliaeetus albicilla*) has been associated with a possible trophy collection of claws (Bökönyi 1978:49). While not identifiable at the species level, the unguis phalanx from Pešterija potentially belonged to a large falcon and may have held similar symbolic significance.

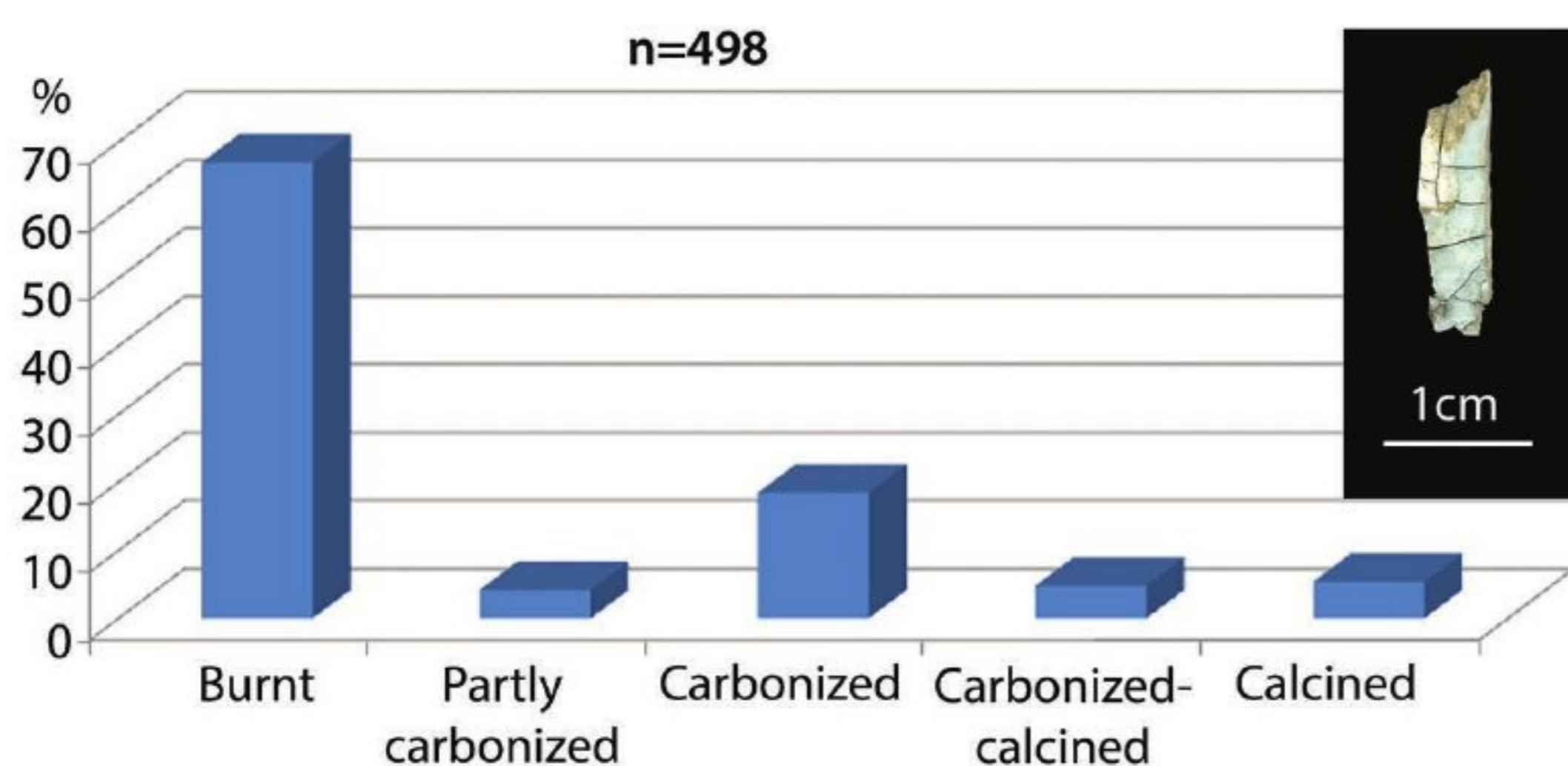


Fig. 8. The distribution of mammal bones based on the degree of burning. Top right: a calcined bone fragment from geological layer 3 of Pešterija Cave (square N/19a).

The faunal assemblage from Pešterija also included five amphibian bone specimens: a humerus of fire salamander (*Salamandra salamandra*), a right ilium bone and a humerus of marsh frog (*Pelophylax* cf. *ridibundus*), and two indeterminate bone fragments which most likely originated from a member of the frog order (Anura indet.).

A particularly notable find, and the sole fish skeletal element in the sample, was unearthed in geological layer 3 (square M20/c). The element in question is a fragmented pharyngeal tooth of vyrezub or pearlfish (*Rutilus frisii*) (Fig. 9.b), one of the largest representatives of the Cyprinidae family. At present, this fish species inhabits the estuaries and the coastal areas of the Black, Azov, and Caspian Seas, and undertakes seasonal spawning migrations to their tributaries (Kottelat, Freyhof 2007; Boldyrev 2022). However, its migration to the Danube, the largest tributary of the Black Sea, has never been documented in the historical record. The only currently extant Danubian populations are landlocked, inhabiting several subalpine lakes and a short river flowing through Austria (Zauner, Ratschan 2005; Schmall 2007; Schmall, Ratschan 2010). However, ancient DNA analysis of cyprinid pharyngeal teeth from several Mesolithic sites in the Iron Gates has confirmed that they originated from vyrezub (Živaljević et al. 2017a). In the Iron Gates Late Mesolithic, pharyngeal teeth of this species were commonly modified and worn as garment appliques, which makes the occurrence of the tooth from Pešterija Cave even more significant (discussed in more detail below). In addition, unmodified vyrezub pharyngeal bones and

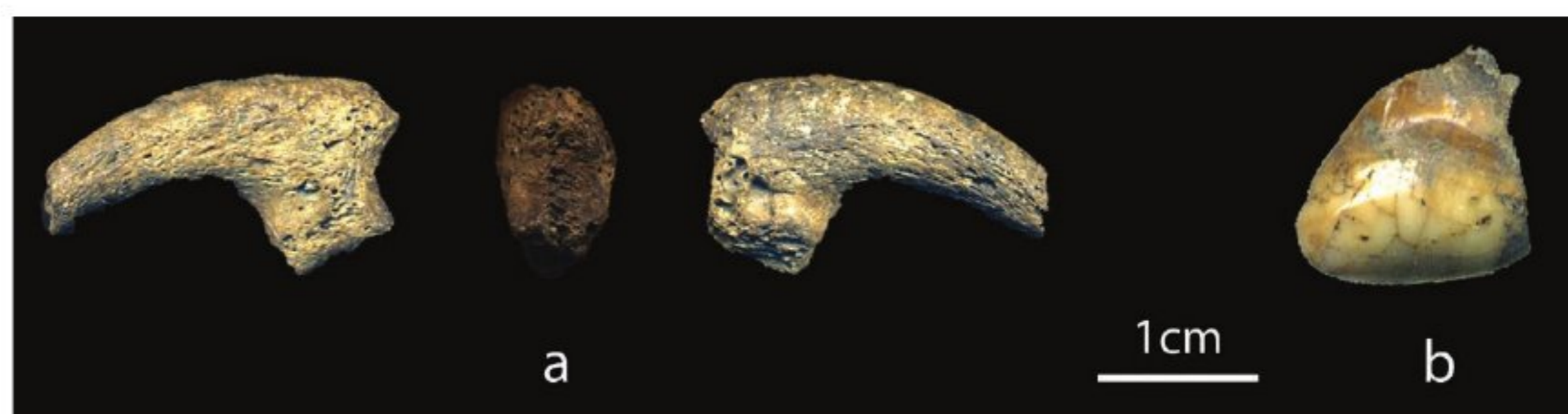


Fig. 9. a An unguis phalanx (talon) of a bird of prey from geological layer 3 of Pešterija Cave (square M19/a). b vyrezub pharyngeal tooth from the zone with lighter sediments in geological layer 3 (square M20/c) (photo Ivana Živaljević).

teeth have also been identified in the faunal assemblage from the Mesolithic layer at Bukovac Cave, in the Resava River valley (a tributary of the Velika Morava, which flows into the Danube) (Živaljević et al. 2018). This suggests that the Black Sea vyrezub populations were entering the whole stretch of the Danube (including some of its tributaries) during their spawning migrations, at least up to the Middle Holocene.

The molluscan assemblage from Pešterija also includes species known from

other Mesolithic sites, as shell fragments of the Roman snail (*Helix pomatia*) were retrieved from geological layers 3 and 4. *Helix* gastropods have been documented at several final Pleistocene and Early Holocene sites throughout the circum-Mediterranean region, and were most likely used in the inhabitants' diet as part of the 'broad spectrum revolution' (Lubell 2004a; 2004b). Other local gastropods (Gastropoda indet.) were also identified in the sample, but they were too small to be used as a dietary source. In addition, two fragments of freshwater mussel (*Unio* sp.) were found in layer 3. At several Mesolithic sites in the Iron Gates region (Padina, Schela Cladovei, Kula), the damage observed on the anterior part of recovered *Unio* shells suggests they were cracked open using some form of tool, indicating their use as a dietary source (Clason 1980; Pickard et al. 2017; Živaljević et al. 2017b). Due to their fragmentary condition, this kind of damage could not be identified on the specimens from Pešterija; however, it is noteworthy that one of them revealed traces of use, as discussed in further detail below.

Butchery marks

Traces potentially associated with butchering were observed on the previously mentioned chamois metatarsal fragment from geological layer 3 (square N19/a). This bone bore transverse scraping marks

and an overlying long cut mark. In addition, two first phalanxes – of a red deer from layer 3 (square N19/b), and an unidentified ruminant from layer 4 (square L19/c) – were most likely cracked with the intent of extracting marrow.

Lithic artefacts

Technological analysis

In geological layer 3, a total of 78 stone artefacts were collected. Among these, two cores (one yielding blades and one yielding blades and flakes), 19 unretouched flakes, 18 blades and bladelets, 10 retouched tools (nine of which were made on bladelets), and 29 chips and small flake fragments were identified. The majority of artefacts (excluding flakes and small fragments) were crafted from chert (26 pieces) among which are six pieces which, based on macroscopic characteristics, can be classified as ‘Balkan flint’ (Tab. 3). At least one of them is typical (yellowish-brown, white spotted), while the others match the colour and structure of the ‘Balkan flint’ varieties confirmed in neighbouring Bulgaria (Gurova et al. 2022). Nineteen artefacts were made from chalcedony, and three of undetermined raw material due to burning effects. Furthermore, one artefact was made from low-quality siliceous rock. The presence of pebble cortex was noted solely on one flake fragment, one blade and one core, suggesting that primary cortex removal occurred off-site for the cores.

The technological composition of the collection indicates that both laminar and non-laminar components are equally represented. The orientation of negatives on the dorsal face of the artefacts, as well as the striking platforms, indicates that both blades and bladelets, as well as retouched flakes, were obtained from cores with unprepared platforms (Tab. 4). This reduction scheme has been confirmed on two cores from the assemblage. One core was formed from a piece of raw material resembling ‘Balkan flint’ and contains two

striking surfaces (Fig. 10.a). The second core, featuring a worn platform edge, was utilized to produce microblades and was struck around its entire perimeter (Fig. 10.b). Different core reduction patterns are also evidenced by several pieces with prepared platform types, as well as by the multidirectional orientation of negatives – more common in flakes than in blades and bladelets. Furthermore, the absence of cortex on the artefacts suggests that primary decortication, and likely core shaping, was conducted off-site.

The reconstruction of the knapping technique was conducted by analyzing multiple attributes, including interior platform angle, lip formation, platform thickness, bulb morphology, bulbar scar, conus formation, and the regularity of blades (Pelcin 1997; Magnani et al. 2014; Hege 2015). Flakes, blades, and bladelets were detached using a soft hammer (Tab. 5). Some of the artefacts were knapped via direct percussion, as indicated by the pronounced bulb and lip formation, and by the presence of bulbar scars. Pieces that exhibit an interior platform angle (IPA) of 90°, a diffuse bulb, and distinct lip formation likely suggest the use of indirect percussion. With regard to blades and bladelets, it has been found that there are no examples with both straight edges and dorsal ridges, which could indicate knapping by pressure technique. The same conclusion arises when it comes to cores – since weakly expressed negative bulbs can be observed on the scars of the detached bladelets, directly below the core platform.

The differences observed between blades and bladelets on one hand, and flakes on the other, relate mainly to the choice of raw materials. Both chert and chalcedony were equally used for blades and bladelets, while flakes were primarily made from chert. Additionally, differences can be noted in the prevalence of ‘Balkan flint’, which was exclusively used for crafting blades and bladelets (Figs. 11,12). The discovery of a core made of ‘Balkan flint’ at Pešterija, along with several small fragments and chips, indicates that

Raw material	Blanks				Retouched tools			TOTAL (%)
	Cores	Flakes	Blades	Bladelets	Flakes	Blades	Bladelets	
Flint	0	11	1	4	1	1	2	20 (40.8%)
Balkan flint	1	0	2	2	0	0	1	6 (12.2%)
Chalcedony	0	6	2	6	0	1	4	19 (38.8%)
Silicious rocks	0	1	0	0	0	0	0	1 (2.1%)
UND	1	1	1	0	0	0	0	3 (6.1%)
TOTAL (%)	2 (4.1%)	19 (38.8%)	6 (12.2%)	12 (24.5%)	1 (2.1%)	2 (4.1%)	7 (14.3%)	49

Tab. 3. General structure and raw material composition of the lithic assemblage from layer 3 of Pešterija Cave.

some artefacts made of this raw material were likely manufactured on-site rather than being transported to the site as finished products. One medial fragment of a blade, likely employed as a sickle insert (see the use-wear analysis results), stands as a potential exception. This artefact could have been made and used as part of a composite tool even before the community inhabited the cave.

		Flakes	Blades	Bladelets	Total
Dorsal scar negatives	Unidirectional	7	1	4	12
	Multidirectional	4	0	2	5
	Diagonal	0	1	0	1
Platform type	Flat	8	1	1	10
	Dihedral	1	0	0	1
	Faceted	2	1	1	4
	Linear	2	0	3	5
	Punctiform	0	1	3	4
	Cortical	1	0	1	2
	Undetermined	1	0	2	3

Tab. 4. Dorsal scar negatives and platform type on artefacts from layer 3 of Pešterija Cave.

The relatively regular fractures on both ends of one distal and two medial fragments of blades made of ‘Balkan flint’ prompted us to conduct analyses to determine whether the blade fractures were intentional. The analysis utilized criteria proposed by Vyacheslav S. Slavinsky *et al.* (2019) and Hugo Anderson-Whymark (2011). Applying those criteria revealed that traces of intentional fracturing can only be observed on a single blade fragment (specifically the one used as an insert), at one fracture point. This is especially evident because this piece displays the point of percussion on the dorsal ridge, enabling a more predictable outcome of fracturing (Slavynski *et al.* 2019). The absence of the Hertzian cone on this fracture may be attributed to the characteristics

of the raw material. Additionally, the other two blade fragments do not display any discernible traces of percussion or flexing fracturing.

Among the retouched tools, abruptly retouched pieces represent the predominant type ($n = 6$). Furthermore, one retouched blade, a tool with an oblique-convex truncation, one retouched flake, and one denticulated tool were also discovered. Within the category of backed implements, the following were identified: three backed bladelets – two fragments with straight backs and one bladelet with a curved back – and two atypical geometric microliths including one segment (Fig. 12.q).

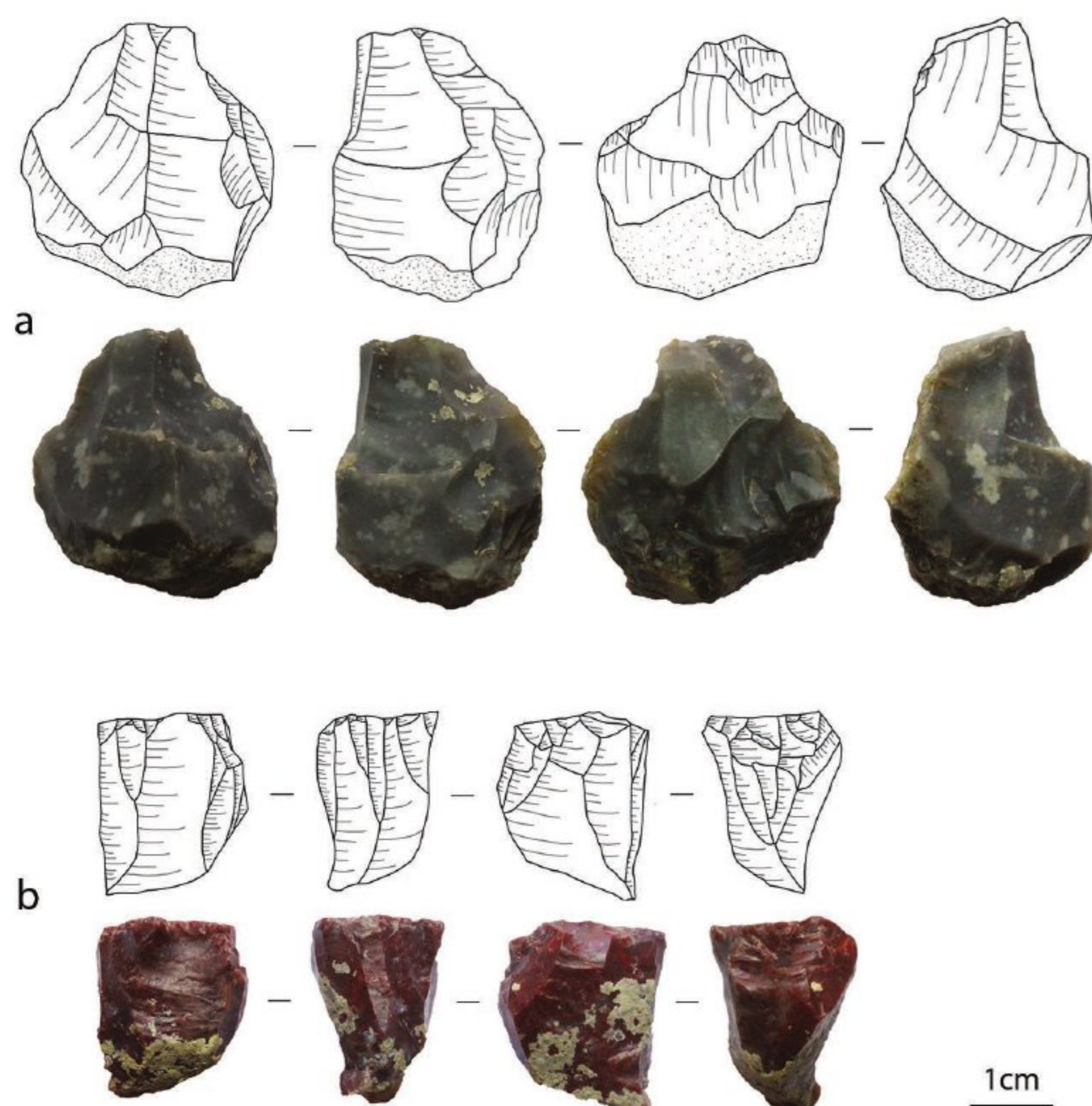


Fig. 10. Cores from layer 3 of Pešterija Cave (photo Danilo Pajović; drawing Sofija Dragosavac).

Use-wear analysis

Fifty-two knapped stone artefacts (Tab. 6) and one blade-like tool made from a fragment of a freshwater mussel shell (*Unio* sp.) – originating from geological layers 3 and 3/4 – were examined for traces of use (Fig. 13.a). The artefacts were analysed via low and high-power approaches (Semenov 1964; Keeley 1980; Vaughan 1985; Jensen 1988; van Gijn 1989; Odell 2001), using Nikon SMZ-U and Leica S9D stereomicroscopes, Olympus BX 51M and Nikon Eclipse ME 600 metallographic microscopes, and a Hirox RH 2000 digital microscope. The knapped stone artefacts were cleaned using detergent and demineralized water in an ultrasonic tank for 15 minutes, followed by rinsing for an additional 10 minutes. During the analyses, samples were further cleaned with ethanol as necessary.

The majority of the analysed artefacts (86%) had been affected by post-deposi-

	Platform thick.	IPA	Bulb morphology			Lip formation			Bulb scar		Conus formation
	(mean)	(mean)	absent	diffuse	pron.	absent	diffuse	pron.	absent	present	
Blades	2.77	/	0	3	0	0	1	2	3	0	0
Bladelets	2	92	2	3	2	1	4	2	7	0	0
Flakes	3.23	93.3	3	7	6	0	6	10	9	7	0

Tab. 5. The presence of attributes for characterizing the knapping technique on artefacts from layer 3 of Pešterija Cave (after Pelcin 1997; Magnani et al. 2014; Hege 2015)

tional surface modifications (PDSM), such as soil sheen (Fig. 13.b.1), glossy appearance, various mechanical alterations, bright spots, patina, general weathering, or a combination of two or more of these (Fig. 13.b.2). The most frequent PDSM is glossy appearance which damages the artefacts by creating a surface that mimics the polish generated by use. Thermal stress was found on 13% of the artefacts and it is distinguished by a colour change and potlid fractures (Fig. 13.b.3), usually associated with low to medium firing temperatures (e.g., Purdy 1975; Patterson 1995; Petrović 2021).

Unfortunately, post-depositional modifications have affected the preservation of the use-wear traces, and a large number of samples are interpreted as undiagnostic (56%), while 25% of the artefacts bear no traces of use. The non-diagnostic samples are interpreted as probably used, but the micro traces have been concealed or removed by physical and chemical alterations and the exact worked material could not be determined. Traces characteristic of processing animal matter are detected on 6% of the artefacts examined, vegetal materials on 2%, while 11% of the artefacts have only macro traces suggesting the use of medium-hard, medium or soft materials. The micro traces of hard animal materials such as bone or antler are represented by flat and melting topography, and covered

linkage of polish. Topography characterizes the morphology of the polish, while linkage describes the connectivity of diverse polish features and levels of polish development more clearly, indicating the material, activity and time spent to modify a certain item. The texture can be smooth, or smooth and greasy/matt, and rough, or rough and greasy/matt, while topography can be domed, flat, pitted, granular, melting, cratered, or similar (e.g., van Gijn 1989). Linkage categories include open, tight, half-tight, compact, and indeterminable. The processing of hide/like materials is evidenced by step and halfmoon terminations (Fig. 13.c.1), rough texture (Fig. 13.c.2), granular topography and open linkage, suggesting a short period of use.

The evidence for working of vegetal matter at Pešterija is noted on one blade fragment used as an insert, from geological layer 3 (square N20/a). Macroscopic analysis showed snap and step scar terminations and developed edge rounding (Fig. 13.c.3). The oblique bi-directional trend testifies that the insert was used in a cutting motion. Microscopic observation revealed a smooth texture, flat topography and covered linkage identifying the micro polish as resulting from processing of vegetal matter, further implying a siliceous-rich plant (Fig. 13.c.4).

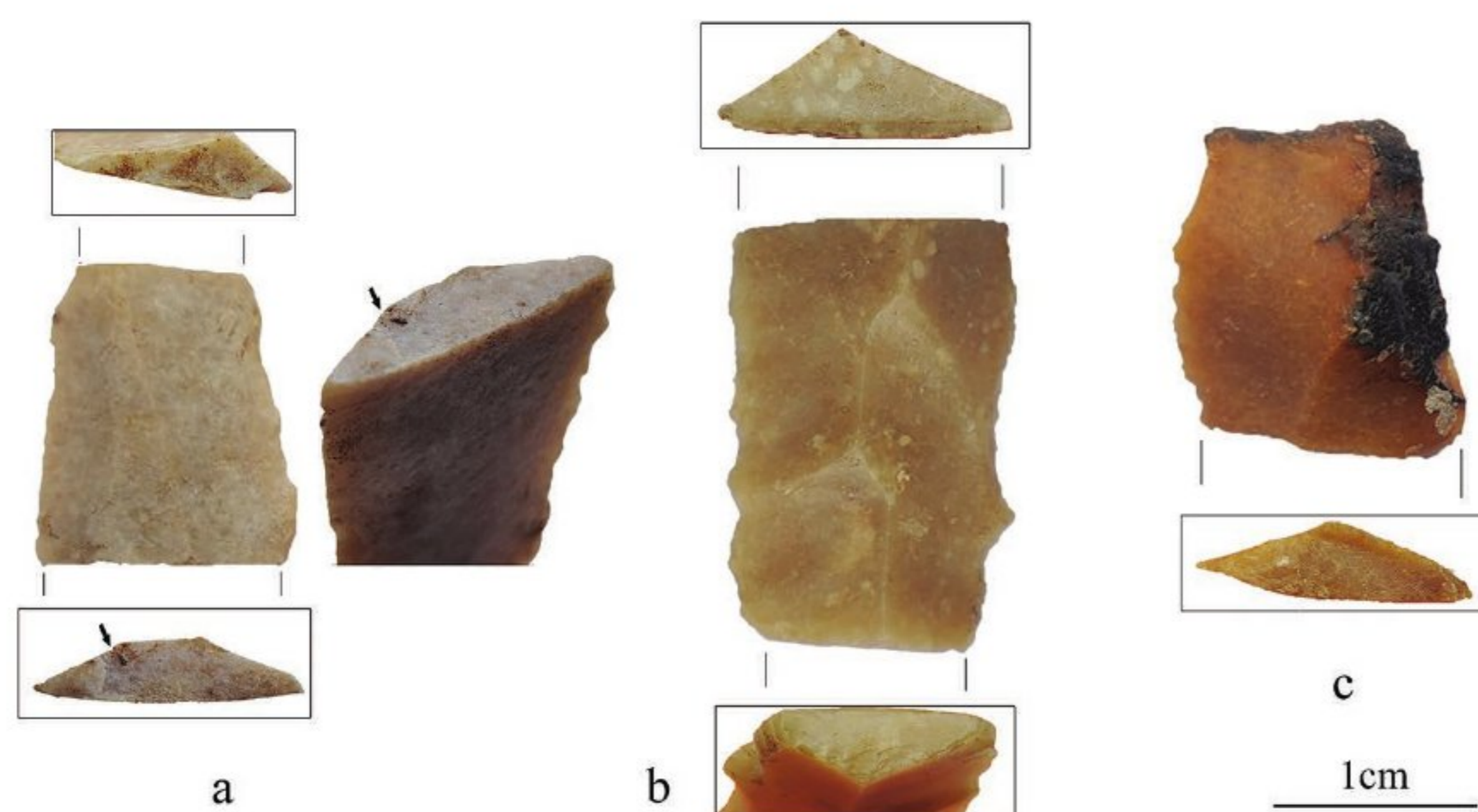


Fig. 11. Fragments of the 'Balkan flint' blades from layer 3 of Pešterija Cave (photo Sofija Dragosavac).

A techno-functional study of the artefacts from Mesolithic layer 5b at Rouffignac displayed similar traces that were also attributed to plant working, in particular, cutting reeds (Visentin et al. 2015, Fig. 65.2). The absence of striations, noted on the insert from Pešterija, indicates the possibility of cutting wild siliceous species (van Gijn 2010). On another part of the used edge, there are random step and feather traces, which suggest that the blade fragment was embedded in a haft or handle. In addition to the tra-

ces of hafting, there are several areas of dark residues. The micro polish is evenly distributed suggesting that the blade was broken before it was used. The observed

traces indicate that the insert was indeed hafted and used as a sickle. The nearest analogies are to be found in Bulgaria, where sickle inserts are considered as an



Fig. 12. Unretouched blades and bladelets (a–g) and retouched tools (h–q) from layer 3 of Pešterija Cave (photo Danilo Pajović; drawing Sofija Dragosavac).

Sample	Layer	Square	PDSM	Thermal stress	Activity	Worked material
1	3,4	M19/b	high glossy appearance			non-diagnostic
2	3,4	M19/b	glossy appearance			not used
3	3,4	M19/b				not used
4	3,4	L19/b	glossy appearance			non-diagnostic
5	3,4	M19/a	glossy appearance			not used
6	3,4	M19/b		yes, potlid fracture		non-diagnostic
7	3	M19/a	glossy appearance			non-diagnostic
8	3	M19/a	glossy appearance			medium material
9	3	M19/a	glossy appearance		cutting	hide-like traces
10	3	M20/d	glossy appearance			non-diagnostic
11	3	M20/d	high glossy appearance, soil sheen			non-diagnostic
12	3	M20/d	glossy appearance			non-diagnostic
13	3	M20/d	glossy appearance			non-diagnostic
14	3	M20/d	glossy appearance			non diagnostic
15	3	M19/d				not used
16	3	L19/c	high glossy appearance, traces of metal	yes, potlid fractures		non-diagnostic
17	3	M20/b	glossy appearance			non-diagnostic
18	3	M20/b	glossy appearance			not used
19	3	N19/b	patina			not used
20	3	N20/a	glossy appearance	yes, potlid fractures		not used
21	3	N20/a			cutting	plant
22	3	M19/b	light glossy appearance, white/blue patina			not used
23	3	M21/a	soil sheen, glossy appearance, bright spot			non-diagnostic
24	3	N20/a	glossy appearance			not used
25	3	N20/a				not used
26	3	N20/a	glossy appearance, soil sheen			non-diagnostic
27	3	L19, M19, N19/a,b, H20/a,b	soil sheen, glossy appearance			not used
28	3	M20/b	glossy appearance, soil sheen			non-diagnostic
29	3	M19/b	glossy appearance, soil sheen			not used
30	3	N19/a	glossy appearance, soil sheen			hard animal material
31	3	N19/a	patinated			hide-like
32	3	N19/a	glossy appearance, metal			non-diagnostic
33	3	L19/a	glossy appearance, patina			non-diagnostic
34	3	N20/b	glossy appearance, soil sheen			soft, soft-medium material
35	3	N20/b				non-diagnostic
36	3	L19/d	glossy appearance			non diagnostic
37	3	L19/c	patina	yes		non-diagnostic
38	3	M19/b	light glossy appearance	yes, potlid fracture	cutting	soft-medium material
39	3	M19/b	glossy appearance		cutting	medium, medium-hard material
40	3	M19/b	high glossy appearance	yes		non-diagnostic
41	3	M20/b	light glossy appearance			medium
42	3	L20/d	glossy appearance			medium-hard material

Tab. 6. Use-wear analysis results.

Tab. 6 continued

43	3	L20/d	altered			non-diagnostic
44	3	M21/a	altered	yes		non-diagnostic
45	3	L20	bright spots, patina			non-diagnostic
46	3	L20	high glossy appearance			non-diagnostic
47	3	L20/a	high glossy appearance			non diagnostic
48	3	L20/a				non-diagnostic
49	3	L20/d	glossy appearance			non-diagnostic
50	3	L20/d	glossy appearance			non-diagnostic
51	3	L20/c	light glossy appearance			non-diagnostic
52	3	L20/c	light glossy appearance			not used

indicator of agricultural practices in the Early Neolithic as they were found in abundant quantities (Gurova 2012; 2014).

Osseous tools and possible ornaments

Osseous tools

Manufacturing and usage traces were detected on several specimens, such as a red deer mandible (Fig. 15.a) from geological layer 3 (square M21/d), a fragment of a large mammal bone (potentially nasal) with a re-touched edge, found in layer 3 (square M20/2), and the aforementioned *Unio* shell fragment (Fig. 14) retrieved from layer 3 (square N20/b).

The basal fragment of the red deer mandible discovered in square M21/d exhibited multiple sets of diagonal cut marks at varying angles, indicative of butchering (*cf. Binford 1981*), but it also displays evidence of additional manipulation and use. Specifically, it appears to have been intentionally fractured to create a 'point', with the surface of the break showing traces of polishing. Moreover, the traces on the 'pointed' portion suggest that the object was used in some manner (Fig. 15.a).

Two specimens (both from layer 3, square M19/c) could be associated with tool types already known from other Mesolithic sites in the wider region. The first one is an artefact made from a longitudinally split long bone diaphysis of a large mammal

(Fig. 15.b). It was longitudinally broken but remained in use even after this. The preserved working edge is trimmed and concave, which is reminiscent of tools from the site of Vlasac which have been interpreted as chisels. At Vlasac, chisels were made from aurochs (*Bos primigenius*) metatarsals, by cutting off a part of the proximal end to produce a handle, and the work-

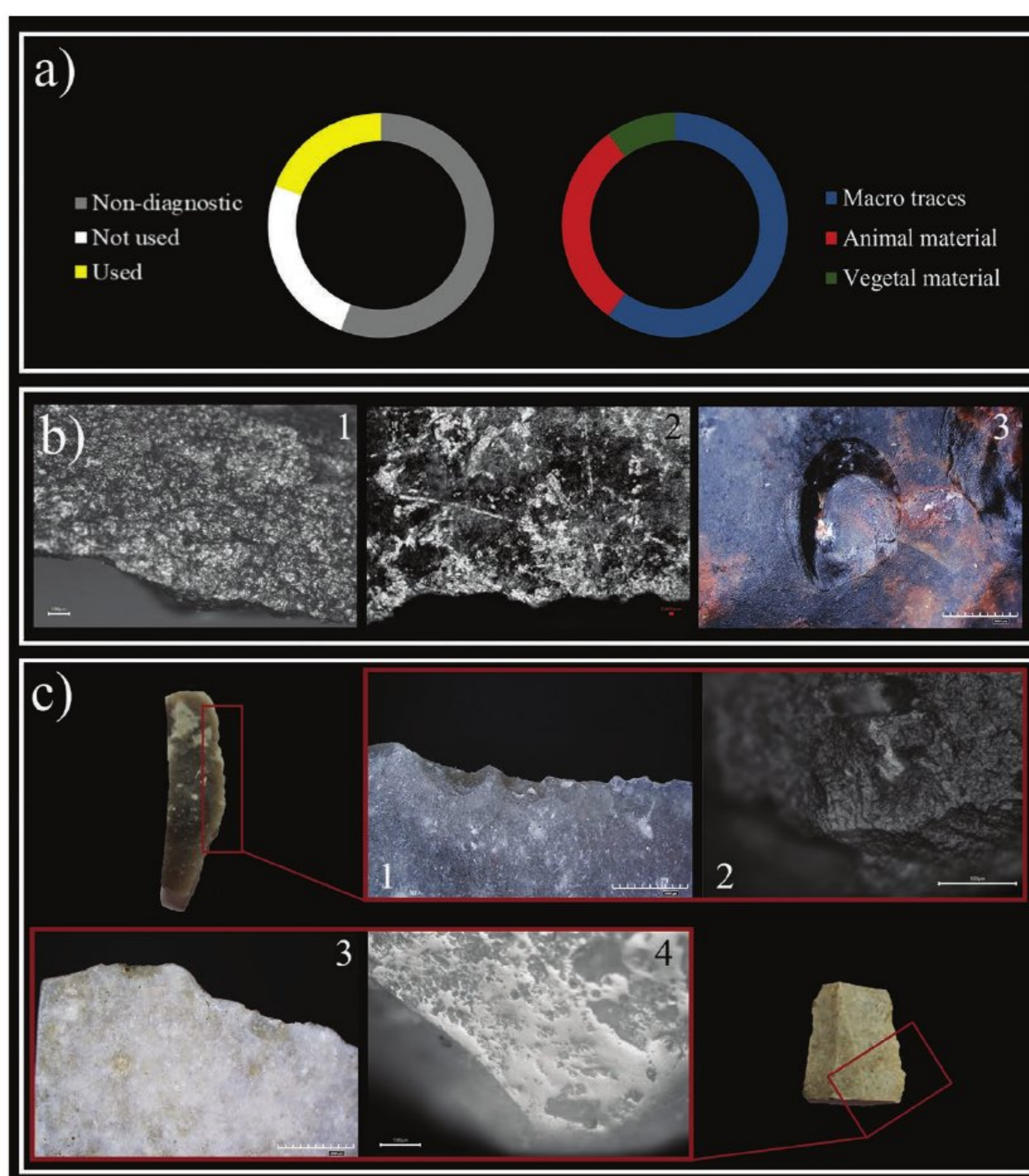


Fig. 13. a Use-wear results of the Pešterija Cave sample. b post-depositional surface modifications (PDSM): 1 soil sheen; 2 combination of soil sheen and glossy appearance; 3 potlid fracture as a result of thermal stress. c worked materials: 1 step and halfmoon macro terminations, hide processing; 2 rough texture, hide processing; 3 snap and step macro terminations with edge rounding, plant working; 4 flat topography and smooth texture, plant working (photo A. Petrović).

ing part was trimmed into a fan-shaped or semi-circular edge. The length of such tools was usually between 8–10cm, and they were most likely used in woodworking. In addition, chisel-like artefacts with a similar trimmed fan-shaped, flat, or circular working edge, were also made from red deer antler and wild boar (*Sus scrofa*) tusks (Srejović, Letica 1978; Borić et al. 2014; Cristiani, Borić 2021). The fragmented artefact from Pešterija was made from different raw material (*i.e.* from a long bone of a ruminant smaller than aurochs), but the similarity in the manufacture and the shape of the working edge suggests that it could have also been used as some sort of chisel.

The second specimen, a small antler tine fragment with a partially preserved working edge, also has analogies with the osseous industry from the Iron Gates sites. It is reminiscent of a fairly ubiquitous group of cylindrical and semi-cylindrical bevelled tools from

Vlasac, made from red deer antler beams or tines, where the active part had been produced by percussion, oblique cutting and scraping to form a wide, usually fan-shaped edge (Srejović, Letica 1978). Based on their morphology and presumed function, such tools have been interpreted as hoes, axes, and axe-hammers (Srejović, Letica 1978), *i.e.* as chisels, axes or blades (Cristiani, Borić 2021), and were most likely used in tree-felling and/or woodworking. Apart from Vlasac, such tools have been found at many Iron Gates sites – Alibeg, Lepenski Vir, Răzvrata, Hajdučka Vodenica, Icoana, Ostrovul Banului, Schela Cladovei, Ostrovul Corbului, Velesnica and Kula (Vitezović 2011; 2017; 2021; Boroneanț, Mărgărit 2017; Mărgărit, Boroneanț 2017; Mărgărit et al. 2017a; 2017b; 2018a; 2023; Živaljević et al. 2017b; Boroneanț et al. 2018). Given that the antler artefact from Pešterija was only partially preserved, the exact type could not be determined, but it was most likely some sort of cylindrical or semi-cylindrical bevelled edge tool.

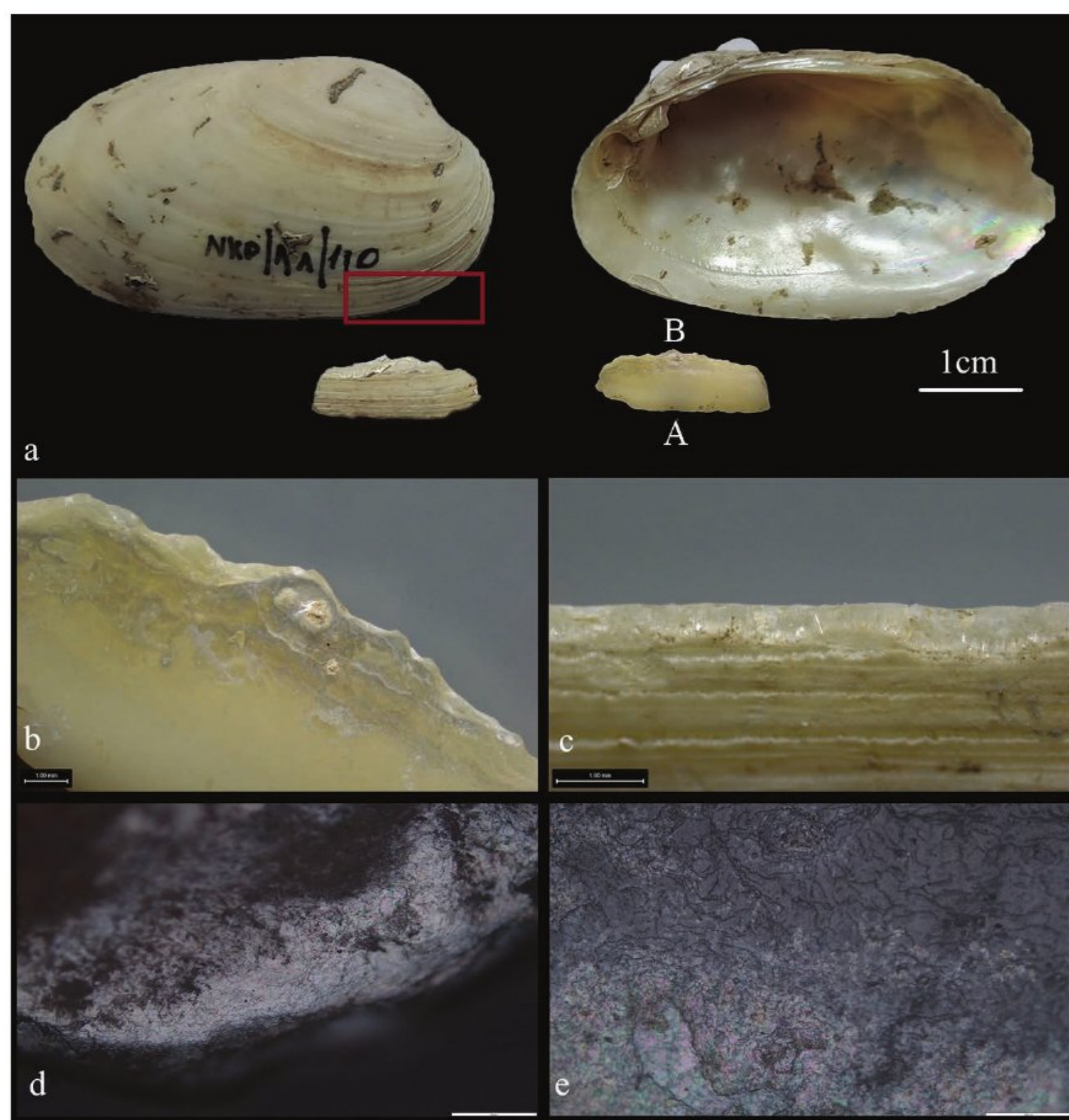


Fig. 14. a outer and inner sides of the valve of a mussel (*Unio crassus*) from the reference collection (Laboratory for Bioarchaeology, Department of Archaeology, University of Belgrade), Viminacium (NKP-11/110,131) and a blade-like tool made on the shell fragment found at Pešterija Cave. b macro trace, snap terminations and overlapping distribution, B side. c macro traces, short transitional striations, A side. d micro traces, smooth to rough texture, B side. e micro traces, granular topography and polish distribution, B side (photo A. Petrović).

A blade-like tool made from freshwater *Unio* mussel shell fragment was recovered from geological layer 3 (square N20/b). It was manufactured by shaping the fragment of the shell ventral marginal edge (Fig. 14.a). The most pronounced area of use is on the B side, where step scarring occurred with an overlapping distribution (Fig. 14.b). The trend of the traces is unidirectional oblique towards transitional, which is associated with a mixed motion of cutting and scraping. Macro traces are indicative of the working of hard to medium-hard material, possibly of mineral origin. On the opposite, A side, less developed traces with snap terminations are present, presumably from handling. Short striations directed transitionally are noted inside the macro scars (Fig. 14.c). Similar traces are observed when working the mineral materials, such as clay (Mărgărit et al. 2021. Fig. 3).

The diagnostic micro traces with smooth to rough texture, granu-

lar to flat topography and covered linkage are found on the B side (Fig. 14.d-e). Based on both macro and micro traces, it is possible that this zone was used to process hard animal matter, either bone or antler. The micro traces on the A side show no visible striations, which is to be expected when processing clay, as previously shown by the experiments (Mărgărit et al. 2021.Figs. 3,4). A more probable interpretation of the mentioned traces is the use of the A side for prehension, as the small, snap traces could have been made to support the grip of the hand. Another possibility is that this area was indeed used briefly to process a mineral matter, and then subsequently became the handle. Brief usage would explain the absence of the micro striations.

Possible ornaments

In addition to the two bone artefacts, another fragmented bone item was discovered in layer 3 (square L19/d), its specific function remaining somewhat ambiguous. It is a small fragment of a diaphysis of a large mammal long bone, with a partially preserved circular perforation (Fig. 15.c). This artefact could have been a bone pendant, similar to the perforated objects known from Vlasac (Srežović, Letica 1978) and Cuina Turcului (Mărgărit et al. 2020). Other potential pendants or clothing appliqués include animal teeth specimens – an upper right canine and a lower left first incisor of

red deer, and the aforementioned vyrezub pharyngeal tooth.

The red deer upper right canine (Fig. 16) was found in the zone of ashy sediment in geological layer 3/4 (square L19/a). Based on the size, morphology, closed root and heavy wear (cf. d'Errico, Vanhaeren 2002), it was determined that it originated from an older male, probably aged between six and 10 years. The canine was manipulated to a great degree, but the exact purpose of these modifications remains unclear. The occlusal surface of the crown wear is quite long and is completely covered with traces of polishing, and there are numerous, short overlying cut marks in several directions, inflicted by a very thin knapped stone tool. They were mainly oriented diagonally to the tooth-long axis, with a smaller number of transversal cut marks. Furthermore, the lingual surface of the crown exhibited three or four deep oblique cut marks, likely inflicted during the extraction of the tooth from the alveolus.

Throughout the Upper Palaeolithic and the Mesolithic, red deer canines were widely used as personal adornments, as demonstrated by numerous discoveries from burial and occupational sites across Europe (e.g., Vanhaeren, d'Errico 2001; d'Errico, Vanhaeren 2002; Rigaud 2011; Grünberg 2013; Macăne 2022). In the Balkans, they have been documented in

Epipalaeolithic contexts in the Iron Gates (Cuina Turcului and Climente II), Bosnia and Herzegovina (Badanj), Croatia (Vela Spila and Vlakno) and Greece (Kastritsa and Klihi), whereas their use during the Mesolithic was primarily restricted to the Adriatic coast (Nugljanska peć, Pupičina peć, Vlakno and Lim 001) (Cristiani et al. 2014a; Borić, Cristiani 2016; 2019; Cărciumaru, Nițu 2018; Cvitkušić et al. 2018; Mărgărit et al. 2020; Cvitkušić, Vujević 2021). Typically, such ornaments were made by drilling or carving a perforation into the root; however, the specimen from Pešterija lacked such perforation. Nevertheless, given the numerous traces of polishing and cut marks, as well as the presence of dark brown-blackish matter (possibly adhesive?) on the apex of the root and the tip

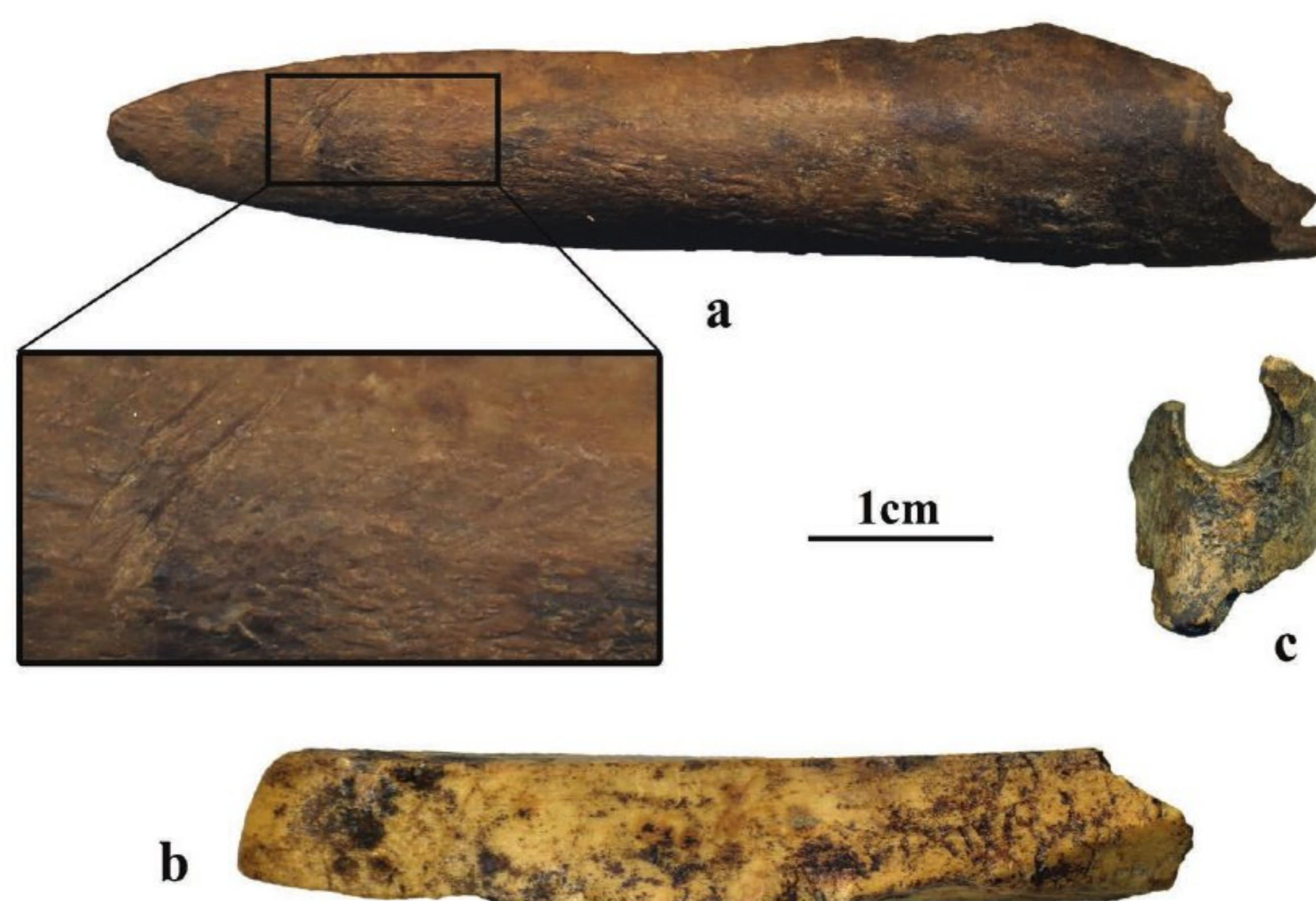


Fig. 15. a a fragment of a red deer mandible from geological layer 3 of Pešterija Cave (square M21/d), exhibiting traces of butchery and possible use. b a longitudinally broken bone tool, possibly a chisel (from geological layer 3, square M19/c). c a fragment of a bone object with a partially preserved circular perforation (from geological layer 3, square L19/d) (photo Ivana Živaljević).

of the crown, it can be assumed that the tooth was manipulated with a similar intention.

According to Francesco d'Errico and Marian Vanhaeren (2002) and Solange Rigaud (2011: 79, 139), the presence of unpaired canines could suggest that these ornaments circulated in gift exchange networks. This interpretation seems particularly plausible in cases when a large number of unpaired canines occur in an assemblage, especially if they exhibit different manufacturing traces and techniques. The specimen from Pešterija is the only red deer canine in the assemblage, so it remains unclear whether it originated from an animal caught locally or was obtained through exchange. Nevertheless, it is worth mentioning that other red deer teeth were also present in the faunal sample from the site. One of them – a left first incisor – bore a small dent and several dark specks on the root, which could be indicative of ornament fastening and suspension.

The vyrezub tooth from Pešterija was fragmented (Fig. 9.b), so it was not possible to determine whether it bore a perforation or binding compound residues on the neck, which was a common suspension technique of vyrezub teeth ornaments in the Iron Gates (Cristiani, Borić 2012; Cristiani et al. 2014b; Mărgărit et al. 2018b). However, the absence of visible traces of modification or use does not exclude the possibility of its non-local origin. The Pešterija Cave is located about 100m above the small Zvonačka River, which flows into the Jerma (a tributary of Nišava), thereby placing it within the Danube drainage basin. Nevertheless, the site remains distant from known migratory routes of vyrezub, at least based on available data. For instance,

current populations in the Dnipro and Don basins primarily spawn in larger rivers, typically those spanning at least 20–30 meters in width (Boldyrev 2022), and they do not migrate to smaller tributaries. The isolated populations in Austria do undertake short migrations from smaller Danube tributaries to lakes, but this is probably a consequence of habitat fragmentation and dam building in more recent times (Schmall, Ratschan 2010). It is also worth noting that no other fish remains were recovered from Pešterija, save for this particular tooth. Consequently, it seems plausible that it was acquired through exchange, possibly with Mesolithic communities in the Iron Gates, or perhaps that it was a part of the clothing of a traveller from afar.

Discussion

As will be evident from the preceding discussion, there is no doubt that the artefacts unearthed from layer 3 of the Pešterija Cave should be attributed to the Mesolithic. In terms of chronology, the site either dates back to the period before the emergence of the Neolithic in the central and eastern Balkans (c. 6300/6200 cal BC) or is contemporary with it. Moreover, the settlement patterns, dietary practices, and technological behaviours recorded at Pešterija closely resemble those observed at Mesolithic sites within the Iron Gates region and throughout the Balkan interior, such as Trebački Krš near Berane (Đuričić 1996), Vrbička Cave near Nikšić (Borić et al. 2019), Neziri Cave in Albania (Hauck et al. 2017), and Hoților Cave situated north of the Iron Gates (Boroneant 2011). Most of these sites in the interior of the peninsula exhibit low numbers of finds, with forest species (primarily deer) dominating the faunal assemblages, while among the artefacts,



Fig. 16. An upper right red deer canine found in the zone of ashy sediment in geological layer 3/4 of Pešterija Cave (square L19/a), exhibiting numerous modifications (polishing and cut marks) (photo Ivana Živaljević).

tools crafted from irregular flakes are common, alongside sporadic instances of backed tools and geometric microliths.

Nevertheless, it is important to consider that most of the sites comparable to Pešterija belong to the Early Mesolithic rather than the Late Mesolithic. Focusing solely on the Late Mesolithic sites (*i.e.* those dating later than *c.* 7500 cal BC), the potential for comparison diminishes substantially as this period in the central Balkans has only been documented in the Iron Gates region. There are similarities between Pešterija and the Late Mesolithic lithic assemblages in the Iron Gates region (Vlasac, Ostrovul Banului, *etc.*), particularly evident in the knapping technology, characterized by the co-occurrence of bladelets and relatively wide blades, tools on irregular flakes, and backed tools (Kozłowski, Kozłowski 1982; Radovanović 1996a; Boroneanț 2000). All this indicates that there was a technological uniformity of Late Mesolithic industries in the interior of the Balkans, which is somewhat different from coeval industries in the hinterland of the coastal zone (*e.g.*, Crvena Stijena, Odmuť), which exhibit a strong Castelnovian component (Kozłowski et al. 1994; Mihailović 2007a; Kačar 2019).

The discovery of the vyrezub pharyngeal tooth in Pešterija, possibly used as an ornament, provides evidence of the social connectivity among the communities dwelling in Pešterija and those in adjacent regions. The utilization of such teeth as personal ornaments has been documented across Central, Southeastern, and Eastern Europe during the late 8th and throughout the 7th millennium cal BC (extending even longer in the latter region). The production of ornaments (most likely garment appliques) included the extraction of teeth from the pharyngeal bone, drilling through or grooving at the tooth neck to enable fastening and suspension by sinew threads and binding organic compounds (Rigaud 2011; Cristiani, Borić 2012; Cristiani et al. 2014b; Rigaud et al. 2014; Mărgărit et al. 2018b). Vyrezub teeth modified in such a manner have been discovered in Late Mesolithic burial and occupational contexts in the Upper Danube region in Germany (Probstfels, Falkensteinhöhle, Burghöhle von Dietfurt, Hohlenstein-Stadel) (Rigaud 2011; Grünberg 2013), in the Iron Gates (Lepenski Vir, Vlasac, Icoana, Schela Cladovei, Kula) (Srejšović, Letica 1978; Radovanović 1996b; Borić 2003; Borić et al. 2014; Borić, Cristiani 2016; 2019; Živaljević 2017; Živaljević et al. 2017b; Mărgărit et al. 2018a), in the Crimea (Shan-Koba, Zamil-Koba I) (Kraynov 1938; Bibikov et al. 1994) and

the Dnipro Rapids region in Ukraine (Mar'ivka, Vasyliivka II, Skelia-Kamenolomna) (Telegin 1991; Lillie et al. 2020; Haskevych 2022).

Mesolithic communities residing along the Danube, Dnipro, and Crimean rivers certainly had first-hand knowledge of schools of vyrezub during their seasonal migration to these waterways, especially during spawning (between April and May, *cf.* Kottelat, Freyhof 2007; Schmall, Ratschan 2010). Although these fish were caught locally in all mentioned regions, the utilization of the same element from the same species underscores a notable level of connectivity and shared concepts regarding bodily adornment and meanings attributed to the fish across a broad geographical area. The occurrence of a vyrezub tooth at Pešterija Cave indicates that such concepts and practices also spread beyond the natural habitats of the species, *i.e.* through exchange networks.

The differences between Pešterija Cave and the coeval sites in the Iron Gates largely stem from the fact that Pešterija, unlike the settlements in the Iron Gates, represented a temporary hunting camp where various activities were carried out. Opportunities to utilize diverse resources, including the forest fauna found on the slopes of Asenovo Kale Hill, were available close to the cave. Since there are no indications that Mesolithic communities stayed in the cave for extended periods or that the cave was inhabited by a large group, it is logical to assume that a larger settlement – which could have served as a base camp – probably existed in the proximity of Pešterija.

At this point, the question arises of how to explain the presence of Mesolithic groups in the mountainous regions of southeastern Serbia, some 20km away from the Nišava River valley, which could have served as a centre of aggregation for the Mesolithic population. Although this issue can only be discussed hypothetically for now, we will provide some possible explanations (which are not mutually exclusive):

- The most logical explanation is that Mesolithic sites in the Nišava Basin have not yet been discovered. However, several caves have been excavated in the Ponišavlje region so far, including those ideally positioned relative to the river, but no Mesolithic remains have been documented (except in Pešterija). For example, no Mesolithic finds were detected in Pešturina Cave (located near the Nišava River on relatively low terrain), at the Pećina kod stene site (situated just a few

meters above the Studena River bed in Jelašnica Gorge), or in the Potpeč Cave on the banks of the Visočica River – which provides evidence of fishing at the beginning of the Last Glacial Maximum (the results of research are yet to be published).

- The settlement of hilly-mountainous areas in the interior of the Balkans may have been uneven, influenced by geographic, ecological, and social factors (such as the need to maintain exchange and information networks, *etc.*, Whallon 2007; 2011). In this context, the question arises whether the Upper Ponišavlje region provided favourable conditions for seasonal exploitation of the mountainous zone – as in Istria (Komšo 2006) and northern Montenegro (Mihailović 2007a; Borić et al. 2019) – or if the settlement of this part of the peninsula occurred for other reasons.
- Regarding the previously mentioned points, it is worth noting that two out of three radiocarbon dates obtained suggest that the occupation of Pešterija Cave aligns chronologically with the emergence of the Neolithic in the central and eastern Balkans, dated c. 6300/6200 cal BC. If there was territorial competition between Mesolithic and Neolithic groups, it could have led to the retreat of Mesolithic communities into sub-optimal ecological zones on the fringes of areas best suited to agriculture (Forenbaher, Miracle 2006; Radovanović 2006; Mihailović 2021).

The notion of contemporaneity and the role of social factors is supported not only by the homogeneity of Mesolithic technology and the evidence of the transportation of the vyrezub tooth, but also by the presence of artefacts made from ‘Balkan flint’ and (likely) sickle inserts in Pešterija. Similar findings were already documented in the Early Neolithic of the Iron Gates and northwestern Bulgaria (Borić 2011; Gurova 2012; 2014; Gurova et al. 2022). Artefacts made from ‘Balkan flint’ have been previously documented in Late Mesolithic layers at Vlasac, Padina, and Lepenski Vir (Kozłowski, Kozłowski 1982; 1984; Gurova et al. 2022) and may represent the earliest evidence of contacts between Mesolithic and Neolithic groups (Mihailović 2007b). Of course, it remains to be seen whether the raw material from Pešterija indeed belongs to the typical ‘Balkan flint’ category. However, even if this is not the case, it is worth noting that Mesolithic and Neolithic communities utilized various types of this raw

material (Gurova et al. 2022). The use of this material carried not only economic significance, but also social importance, indicating social openness (Mihailović 2007b).

Conclusions

After decades of searching (albeit not systematically) for Mesolithic sites in the interior of the Balkans, one such site has indeed been discovered: Pešterija Cave. Nevertheless, this site was not in proximity to the Iron Gates, significant rivers, or any easily accessible terrain. Instead, it was found in an unexpected location – distant from the Mesolithic group aggregation hubs, c. 20km away from the Nišava valley, situated in a relatively remote area in southeastern Serbia. Nevertheless, Pešterija Cave represents a more or less typical Mesolithic temporary settlement with characteristic tools and faunal remains. This goes against (perhaps unrealistic) expectations that larger, archaeologically visible semi-sedentary Mesolithic settlements near the Danube would be discovered first.

Pešterija Cave testifies to the fact that Mesolithic populations (apart from the Danubian region) did inhabit the interior of the Balkans, which had long been assumed but lacked confirmation. It remains to be determined in which geographic areas and under what circumstances the aggregations of Mesolithic groups took place, what settlement patterns these communities practiced, what was their social connectivity like, and what kinds of interactions these populations had with Neolithic ones.

The presence of ‘Balkan flint’ and sickle inserts suggests contact of Mesolithic groups that inhabited Pešterija with Neolithic communities in neighbouring areas – most likely from northwestern Bulgaria. This would imply that interactions between Mesolithic and Neolithic groups, previously documented only in the Iron Gates region (Borić, Price 2013), were probably not an isolated but a widespread phenomenon. In any case, the discovery of the Mesolithic at Pešterija Cave opens up a completely new perspective in the Mesolithic and Neolithic research of eastern Serbia and northwestern Bulgaria. This applies particularly to the Ponišavlje region, where recent research has unveiled evidence of human settlement spanning from the Last Glacial Maximum to the advent of the Neolithic.

Acknowledgements

We would like to acknowledge Predrag Radović for technical help in preparing the manuscript. Funding was provided by the NEEMO project of the Science Fund of the Republic of Serbia (7746827) to D. M., V. D., S. D., K. B., A. P. and M. Dj., by the ARCHAEOWILD project of the Science Fund of the Republic of Serbia (7750265) to I. Ž, and NSERC RGPIN-2017-04702 and RGPIN-2019-04113 to M. R. We also thank Sahra Talamo for discussion regarding the ¹⁴C dating results.

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