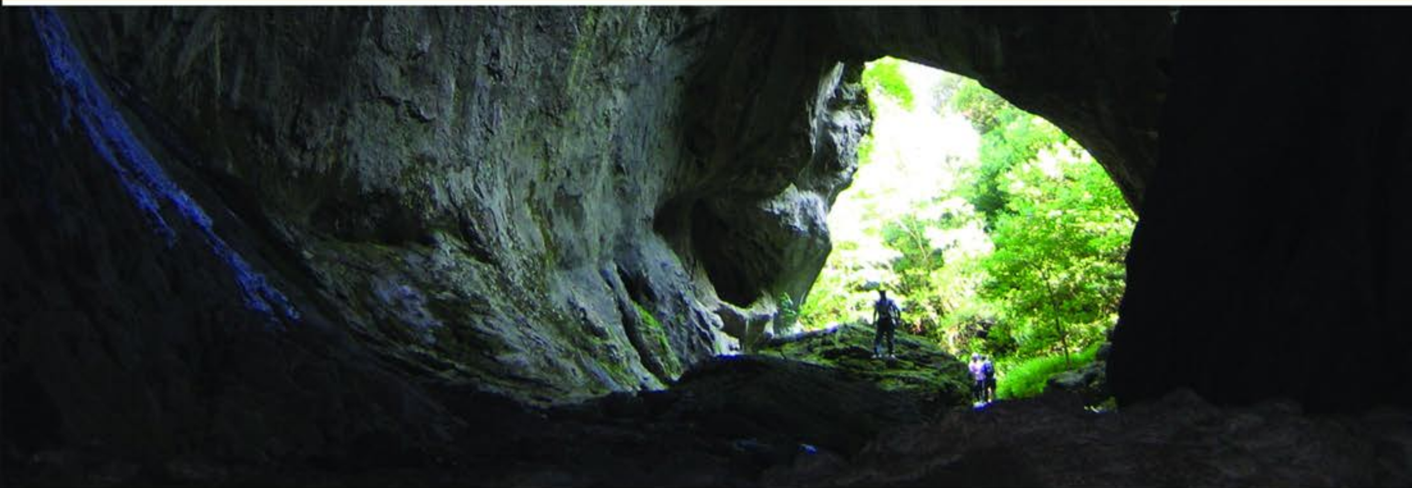
Palaeolithic and Mesolithic Research in the Central Balkans

edited by Dušan Mihailović



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IN THE CENTRAL BALKANS

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Preface

Intensity of investigation of Palaeolithic and Mesolithic has considerably increased in Serbia and Montenegro in last ten years. Large number of sites from all periods has been discovered in eastern Serbia and particularly interesting are Mala and Velika Balanica in Sićevo gorge where the remains of hominids were found together with the artifacts. Investigations in western Serbia were focused on Šalitrena pećina and on Bioče and Crvena stijena in Montenegro. In order to provide maximal geographical and chronological coverage but also to raise methodology of investigation to a higher level many international projects had been organized in recent years and they already started to yield certain results.

Nevertheless, these investigations are still insufficiently known to the academic audience. The need has occurred because of that to publish as soon as possible preliminary results not only of field investigations but also of specialist analyses of samples and material. We tried, having that in mind, to present in this book thematically and chronologically different aspects of current investigations of Palaeolithic and Mesolithic in the central Balkans.

First section of the book includes articles, which present anthropological remains and results of dating. In the work of Mirjana Roksandić and associates are presented remains of modern men from the collection of the Natural History Museum in Belgrade. On the other hand, in the works of Bonnie Blackwell and associates and Bridget Alex and Elisabetta Boaretto ESR and ^{14}C dates for Palaeolithic site Pešturina near Niš are studied in detail. It is the first step in an attempt to comprehend timing and nature of Neanderthal occupation of that cave.

Next two articles are devoted to the investigation of open-air sites. Eric Heffter showed how pedological and geological data, and distance to raw material sources, can aid in creating GIS models which may predict locations of open air archaeological sites. This author with his associates presented first results of surveying of Lower and Middle Palaeolithic sites in the West Morava valley.

In the next section five regional projects are presented. Wei Chu et al. discussed new findings from Aurignacian sites around Vršac. In the report about investigations at Šalitrena pećina (Dušan Mihailović, Bojana Mihailović) are presented result of test trench excavations on the river terrace opposite the cave where Middle Palaeolithic material including one leaf-shaped point (Blattspitz) was encountered in apparently intact geological strata. Tamara Dogandžić with associates and Steven Kuhn with associates presented preliminary results of test trenching in the caves in eastern Serbia where Middle and Upper Palaeolithic artifacts have been found. At the end are presented investigations of Palaeolithic sites in the Niš basin that lasted for ten years (Dušan Mihailović), with special attention paid to the excavations of Velika and Mala Balanica and Pešturina.

In the next two texts were presented results of specialist analyses. Ana Belen Marin presented for the first time results of the archaeozoological analyses from Velika Balanica, while Aitor Ruiz Redondo presented in his article discovery of the first cave site in the region (Selačka pećina 3) with possible Palaeolithic graphic representations.

Two last texts are devoted to the investigation of Mesolithic. Ivana Radovanović with associates presented results from a recent survey and geoarchaeological investigations of the Mesolithic sites in the flatlands and mountainous hinterlands of the Danube Iron Gates region, while Marc Vander Linden with associates presented course and results of investigations of the Mesolithic site Seocka pećina in the near vicinity of the Skadar Lake.

We hope that this book managed, at least to a certain degree, to point to directions and perspective of investigations of Palaeolithic in the central Balkans. We wish to express our gratitude to all authors for being able to prepare their articles for publishing at relatively short notice.

LOOKING FOR HOMININS IN MUSEUM DRAWERS - POSSIBLE UPPER PLEISTOCENE SPECIMENS FROM SERBIA: MORPHOLOGICAL DESCRIPTIONS AND RADIOCARBON DATING

Mirjana Roksandic, Predrag Radović, Bridget A. Alex,
Sanja Pavić, Milan Paunović and Zoran Marković

Abstract: With the exact nature of the interactions between Neanderthals and anatomically modern humans, and the identity of the of the bearers of early Upper Paleolithic technology still open questions essential to expand the human fossil data of Southeast Europe. In our attempt to do so, we investigated a small collection of six previously unpublished human cranial fragments from Serbia, housed at the Natural History Museum in Belgrade and the National Museum in Kraljevo. Tenuous contextual evidence suggested a possible Pleistocene age for the specimens. We conducted a macro-morphological analysis and accelerator mass spectrometry radiocarbon dating in order to assess taxonomical positions and absolute dates for the specimens. Thorough prescreening and chemical characterization of bone samples were used to ensure high reliability of 14C dates. Although the results showed all specimens to be Holocene-aged anatomically modern humans, this should not discourage future research. On the contrary, if indeed we want to understand the early presence of modern humans in the Central Balkans, more research is needed. This includes further checking of old museum collections, but emphasis will need to be placed on new excavations of Pleistocene sites in the region.

Key words: hominins, Pleistocene, Serbia, Upper Palaeolithic

Introduction

The debate over who the bearers of the early Upper Paleolithic (Aurignacian) technology were, and how this technology spread into Europe at around 40ka, is still far from over (Hoffecker 2009). Upper Paleolithic technologies are often equated with the advancement of “anatomically modern humans” (AMHs) into the territory occupied by Neanderthals, and used to suggest their superior behavioral capacities - the presumed “behavioral modernity” (Klein 2000). There is strong support for a relatively abrupt population replacement in Western Europe (Bischoff et al. 1989): with estimates ranging from 5000 years for Western Europe (Higham et al. 2006) to 10,000 years for Central Europe (Kuzmin and Keates 2014). This replacement does not necessitate AMHs’ essential behavioral superiority; and although this is still a predominant paradigm for the European fossil record (see recent critical review by Villa and Roebroeks, 2014), it has been challenged when larger geographic areas are taken into account (Richter et al. 2012). Furthermore, the relatively abrupt replacement of the Middle Paleolithic by the Upper Paleolithic is not necessarily demonstrated for Eastern Europe (Kuzmin and Keates 2014), nor can it be assumed that Upper Paleolithic technologies were introduced by AMHs (Higham et al. 2014). As long as our focus is on well-researched Western Europe, which represents an end point of the AMH migration, we will not be able to fully grasp the dynamics of the interactions between AMHs and Neanderthals that led to the global outcomes. As amply demonstrated by the sites such as Bacho Kiro in Bulgaria (Kozlowski and Ginter 1982), as well as Cioclovina (Harvati et al. 2007), Pestera Muierii (Soficaru et al. 2006) and Pestera cu Oase (Trinkaus et al. 2003; Zilhão et al. 2007; Trinkaus and Zilhão 2013) in Romania, Southeast Europe is essential to this debate. Recent advances in dating techniques have allowed re-dating of a number of key specimens deemed to be Upper Pleistocene modern humans, which were subsequently removed from the Pleistocene record, further emphasizing the importance of the Romanian and Eastern European material (for review See Ahern et al. 2013).

Serbia, covering the southern part of the Pannonian Plain and the Central Balkans, borders Romania to the east and represents one of the probable routes for the expansion of AMHs to Western Europe. Unfortunately, the human fossil record of Serbia is poor relative to the neighbouring countries (Roksandic submitted). Only two Pleistocene AMH specimens had been published in detail so far: a fragmented mandible from the vicinity of Belgrade (Roksandic and Dimitrijević 2001) and a fragmented calotte from Bački Petrovac near Novi Sad (see Radović et al. 2014). Both specimens had been recovered from loess deposits of Serbian Podunavlje, which were formed exclusively during Pleistocene (Nenadić and Bogićević 2010). Since one of these specimens (Bački Petrovac) is now lost, any "new" discoveries from Serbia may be significant for our understanding of the Upper Pleistocene biological and cultural dynamics in Europe.

This prompted us to investigate a small collection of six previously unpublished human cranial fragments housed at the Natural History Museum in Belgrade (NHMBEO) and the National Museum in Kraljevo (NMKV), for which the evidence (however tenuous) seemed to suggest a possible Pleistocene age. The fact that all the specimens were discovered accidentally by non-professional individuals brings serious doubt into the alleged chronological context. Therefore, we first conducted a macro-morphological analysis in order to taxonomically classify the specimens. Then, we prepared the samples for accelerator mass spectrometry (AMS) radiocarbon dating using state-of-the art methods of prescreening and pretreatment — methods now considered routine for Pleistocene bones (Yizhaq et al. 2005; Brock et al. 2010). However, before dating the samples, we conducted additional chemical characterization in order to ensure that the dated carbon derived from human collagen, rather than contaminants or non-human collagen that may have been applied for conservation. The results of our analysis are presented here.

Material and methods

Over the course of 2013 we located six unpublished human cranial fragments of possible Pleistocene origin recovered from Serbia. Five of those are presently housed at NHMBEO and they include: a human mandible from Mečije Rupe cave near Svrljig (reportedly discovered in 1931); a partial human cranium from Kolubara river estuary near Obrenovac (a suburb of Belgrade) discovered in 1952; a fossilized posterior portion of a human neurocranium from an unknown locality; a fragmentary human skull from Iline Vode (Kragujevac municipality); and a fragmentary human parietal from Sava river basin near Ostružnica (discovered in 1947). Another specimen was discovered in 2013 at Kotež (Belgrade) among construction gravel mined from the Danube banks, today part of the NMKV collection. A brief discussion of the conditions of the finds mostly based on museum records was provided for each of the specimens. Macro-morphological description was provided for each of the individuals and their affiliation with fossil hominin groups is discussed using standard morphological features. Age and sex of the represented individuals was assessed using standard methods (Ubelaker and Buikstra 1994).

In order to better interpret the archaeological and paleoanthropological relevance of this material, it was essential to provide chronological context for each specimen. Six specimens have been prepared for AMS radiocarbon dating and dated at the D-REAMS Radiocarbon Laboratory, Weizmann Institute of Science, Israel. Because the specimens have uncertain histories, with regard to collection and storage practices, we took into account the possibility that they were treated with organic glues or consolidants that could compromise the radiocarbon content. Therefore bone samples were subjected to extensive prescreening procedures aimed at identifying potential contaminants. First samples underwent the prescreening procedures applied to all bones at the D-REAMS Radiocarbon Laboratory: measurement of percent insoluble fraction as well as Fourier Transform Infrared Spectrometry (FTIR) of bone powder and insoluble fraction

(Yizhaq et al. 2005). Percent insoluble fraction (%IF) is the percent by weight that remains after dissolution in 1 N HCl, which comprises the organic content of bone as well as any insoluble contaminants. Insoluble fraction values for fresh bone are about 20%, while archaeological bone usually falls below 5% depending on the depositional environment (Van Klinken 1999). Splitting factor (SF) reflects the crystallinity of bone, which increases as bones undergo diagenesis. Fresh bone has a SF between 2.4-2.9, while archaeological bone can range from 3-7 (Berna et al. 2003). SF is calculated from the FTIR spectra of bone powder, as the sum of the height of the peaks at 565 cm-1 and 604 cm-1 divided by the height of the valley between them, measured from a standardized baseline (Weiner and Bar-Yosef 1990). Finaly, the samples were measured by AMS, also at the D-REAMS Radiocarbon Laboratory. Radiocarbon dates were converted to calibrated dates using IntCal13 atmospheric curve (Reimer et al. 2013) with OxCal software v4.2 (Bronk Ramsey 2009).

Results

Contextual information for the specimens in question is essentially minimal and mostly based on the entries into the NHMBEO ledger and handwritten labels associated with specimens. The following list shows *translation labels* for specimens housed at NHMBEO, along with the information from the museum ledger and any additional information (if available):

1) *A human mandible from the Mečije Rupe cave, village Pirkovac near Svrljig, prof. Petar Petrović, July 3rd 1931*. According to the museum ledger, the specimen was apparently found in association with a left mandible of *C. capreolus*. We included this specimen in our paper mostly because of the recent discoveries at the site.

2) *Collection number 205, the upper portion of a human skull, excavated in 1952 by bulldozer at the Kolubara river estuary, near Obrenovac (a suburb of Belgrade)*. The specimen is entered in the museum ledger as "*Pleistocene*". In addition, the Kolubara fragment was allegedly found in association with the remains of other Pleistocene mammals (Roksandic and Dimitrijević 2001).

3) There are no labels/ledger entries associated with the specimen (number 807 is written on the specimen itself). However, the specimen is a part of "Pleistocene" collection; therefore we included it in our analysis.

4) *Collection number 199, fragments of human skull from cultural layer, Iline Vode, 5km south of Kragujevac municipality. Brought by Sergije Matvejev*. There is no additional information for the specimen in the ledger. As a part of the "Pleistocene" collection, we included the specimen in the analysis.

5) *Collection number 202, a fragment of human skull, Sava near Ostružnica, Belgrade, December 8th 1947, gifted by "Brodarsko-bagersko preduzeće"*. In the museum ledger, this specimen lacks contextual information other than that provided by the label and the note that it was "*excavated from Pleistocene sediments*" by a local building company.

The Kotež specimen was discovered in 2013 by V. Radosavljević, a student of veterinary medicine living in Kotež (Belgrade). Radosavljević noted a fragment of a human skull in the gravel load which he purchased for the domestic building project. After contacting archaeology student A. Todorović, the specimen was donated to NMKV. Although the exact stratigraphic context of the find is unknown, we can say with some certainty that it must have been excavated on the banks of Danube by the Pančevo Bridge at Krnjača, where sand and gravel are commercially mined by a local company. At Krnjača, 10 m thick Middle/Lower Pleistocene polycyclic-fluvial deposits are positioned between marshy-fluvial deposits of the Holocene (17-20 m thick) and the Middle/Late Miocene (Sarmatian-Pannonian) clays beneath. The Pleistocene deposits have yielded remains of large mammal fauna (*Mammuthus trogontherii*, *Megaloceros* sp., *Bison priscus*, *and Alces* sp.) (Nenadić and Bogićević 2010: 191).

Macro-morphological descriptions

• The **Mečije Rupe** mandible comprises a largely complete corpus and anteroinferior portions of the rami (Fig. 1). It shows significant post-mortem erosion (located mostly on the external surface) and a fresh cut in the region of the right lateral prominence (probably a result of inadequate excavation technique). Three molars in advanced stages of dental attrition were preserved (left M1 – M2 and right M2). Parts of the enamel are broken off due to taphonomic factors (mesial and lingual surfaces of left M1 crown, mesial surface of left M2, and inferior halves of mesial, bucal and lingual right M2 crown surfaces). Most of the missing teeth were lost post-mortem (or at least peri-mortem), except for the third molars (missing due to hypodontia). In spite of post-depositional damage to the alveolar bone, it is obvious that roots of the molars have been exposed during life by the alveolar bone recession. Although this recession is usually correlated with periodontal processes, the quality of the alveolar margin in Mečje Rupe specimen (which is thin, knife-edged) rather suggests a compensatory eruption due to attrition (Ogden 2008).

Figure 1. A mandible from Mečije Rupe.

The mandible is thick and strongly built. On the anterior symphyseal region, the distinctive mental trigone is bounded by the mental fossae and by the robust lateral/anterior marginal tubercles – forming a chin. Digastric fossae and the genial tubercles are present. Seen in norma lateralis, mental foramina are positioned below P3 – P4. Although there is damage to both of the anterior ramal borders, it is clear that retromolar space would not have been present if the third molars had erupted. In occlusal view, prominentia lateralis is positioned at M1 – M2 and there is no gutter-like extramolar sulcus. The medial face of the specimen shows a shallow submandibular fossa, an inclined and high (at M3 level) mylohyoid line, no planum alveolare and an inclined mylohyoid groove with no bony bridge. The occlusal surface of the first molar displays a five-cusped pattern, while both second molars display four-cusped patterns.

According to Schwartz and Tattersall (2000) a clearly defined chin, as seen in Mečije Rupe, represents an autapomorphic *H. sapiens* feature. Other morphological characters are also in accordance with modern human anatomy (see Mounier et al. 2009). Moreover, the robust morphology of the mandible and dental attrition suggest a an adult male individual.

• The **Kolubara** specimen consists of a damaged frontal, partial parietals and nearly complete occipital bone (Fig. 2). The fragments are distorted, showing multiple cracks and pits, and erosion, mostly due to taphonomic factors. An unprofessional reconstruction, which involved joining of the parietal fragments and occipital bone to the right parietal (today detached), also contributed to specimen's poor state of preservation. On the frontal bone, the supraorbital region is almost complete; however, there is damage to the inferior parts of the zygomatic processes and to the medial part of the left orbital margin. There is a lot of erosion to the outer table of the frontal squama, with wide areas of its original surface missing. The medial portions of the orbital plates are also missing, due to damage to the interior aspect of the bone, revealing spacious and fan-shaped (according to Szilvassy 1986) frontal sinuses, which extend laterally into the orbital roof and up into the squama. The superior parts of the nasals and a small fragment of the left frontal process of the maxilla are preserved. The right parietal is very fragmentary, consisting of the smaller supero-anterior portion still attached to the adjacent bones and the bigger posterior fragment along the sagittal and lambdoid sutures. The left parietal bone is better preserved, but it lacks the most of its inferior portion. The occipital shows a distorted squama, with cracks and the damage to the superior angle; the basilar portion of the bone was not preserved. While the outer table of the occiput is mostly intact, there is considerable erosion to the inner table; this is exactly the opposite of what we observed in the frontals and parietals, where the cerebral surface is less eroded compared to the outer table.

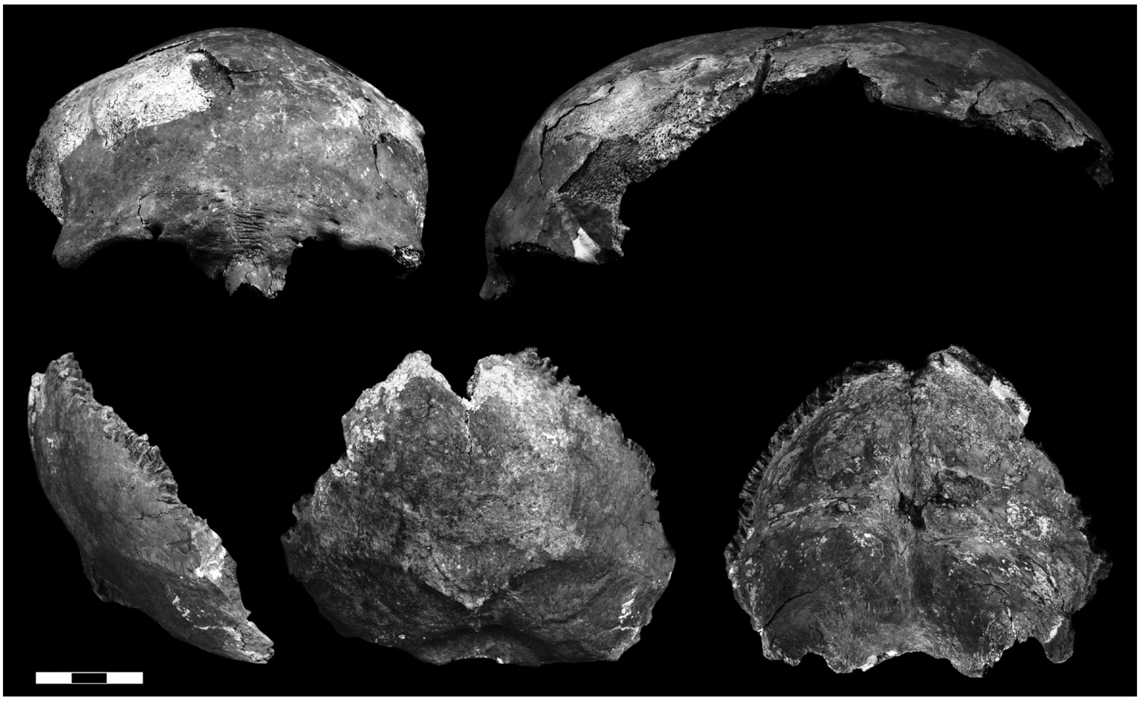

Figure 2. Kolubara specimen.

The Kolubara frontal shows a prominent, bulging squama with frontal eminences. The specimen shows no supraorbital torus; moderately developed superciliary arches are followed laterally by thin supraorbital trigones and there is no supratoral sulcus. Viewed in lateral projection, there is only a slight gabellar projection relative to the nasion. A medial supraorbital foramen (damaged) and a supratrochlear notch are present on the right, and a large, blurred medial supraorbital notch is present on the left; numerous nutrient foramina were detected in the supraorbital region. Orbital plates show small vascular impressions, but there is no *cribra orbitalia*. The supranasal region shows a complex zigzag shaped suture. Although we could not calculate the length-breadth index, preserved fragments indicate a dolichocephalic cranium. The posterior part of the frontal squama and parietals show some slight keeling, but this could be exaggerated by postdepositional erosion and distortion. Both frontal and parietal endocranial surfaces show a normal modern pattern of vascular grooves and arachnoid pits. In spite of the distortion, the occipital squama is evidently curved in lateral view. The nuchal region is robust, showing distinct superior nuchal lines, forming a strong external occipital protuberance at their meeting point. Inferior nuchal lines are also present. Just above the inion, there is a conspicuous triangular depression.

This structure is seen in many modern human specimens and it is quite different from transversely oval suprainiac fossa seen in Neanderthals (Balzeau and Rougier 2010). The appropriate term for the structure is “supranuchal fossa” (Sládek 2000). Despite the damage, the endocranial surface of the occipital shows a specific dural sinus drainage pattern: left dominant asymmetric type 3, according to the classification system of Delmas and Chifflet (1950) – the superior sagittal sinus continues as the left transversal sinus, with right transversal sinus also present but with no appreciable connection with the sagittal sinus.

The Kolubara specimen exhibits a typical modern *H. sapiens* anatomy. Based on the robust occipital region, and the supraorbital morphology, the skull probably belonged to a male individual. While the preserved portion of the coronal suture is mostly opened, the level of sagittal suture closure suggests an adult. However, a more precise age of the individual is difficult to determine based on the available fragments; as Hershkovitz et al. (1997) have shown, sagittal suture ossification does not represent a particularly reliable aging method, as it was found to be age-independent.

• The specimen from an unknown locality (designated only as 807, Fig. 3) represents a posterior portion of a human neurocranium, which consists of a moderately thick, fragmented occipital and parietal bones. The bone is generally in good condition with the endocranial surface particularly well preserved. There is only slight post-depositional erosion on the ectocranial surface. The occipital bone preserves mainly the right part of the occipital planum and a small portion of the right nuchal region. On the endocranial aspect, part of the cruciform eminence is

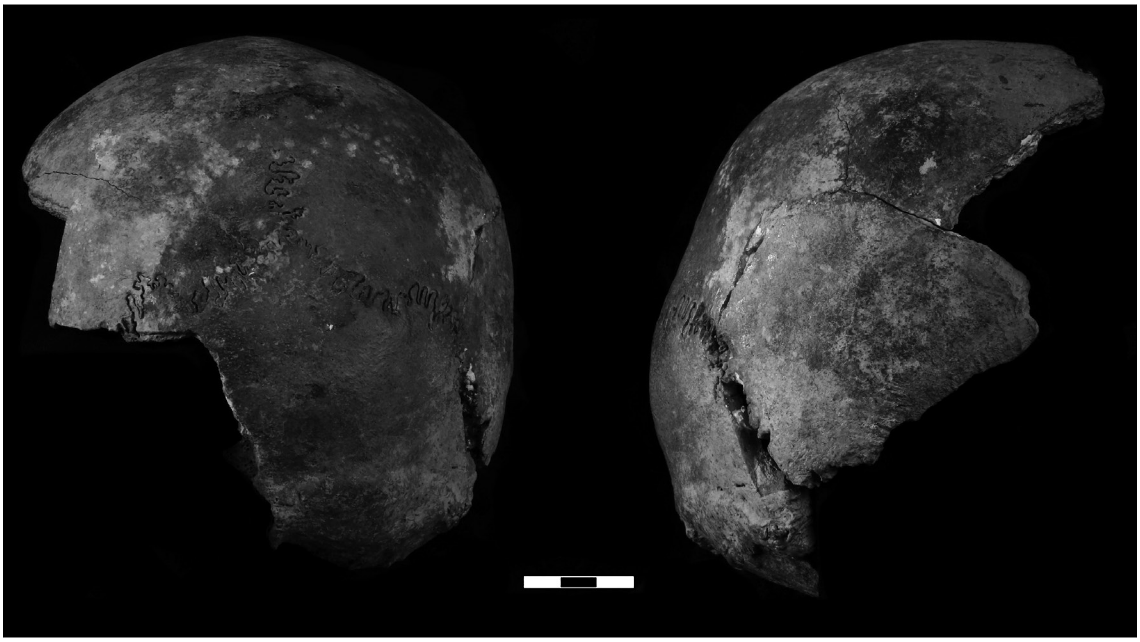

Figure 3. Specimen from an unknown locality (807).

preserved; parts of the cerebral fossae (with the exception of the lower left) and the occipital and parts of the transversal sulci are also preserved. The right parietal bone is more complete, consisting of a large posterior fragment, with both posterior angles preserved. On the lower end, the parietal striae are discernable. The left parietal is less complete, lacking the lateral portion. Parietal endocranial surfaces show a normal pattern of the vascular grooves, sagittal sulcus and arachnoid pits. The medial parts of the lambdoid suture on both sides and a large part of the sagittal suture are preserved. The sutures are deeply denticulated and they show minimal to significant closure.

Viewed in the lateral projection, it is evident that the specimen represents a part of a short, high skull. The occipital displays a modern pattern of the curvature of the squama. Although the exact position of the opisthocranion could not be determined due to the fragmented nature of the specimen, it is obvious that it must have been located high on the squama. The nuchal region is robust, with an external occipital protuberance and conspicuous nuchal lines which outline a torus-like structure for the entire breadth of the bone. There is a shallow triangular depression above the inion, clearly distinct from the condition seen in Neanderthals (Balzeau and Rougier 2010). The endocranial portion of the occipital shows a right dominant asymmetric type 3 dura mater sinus drainage pattern (according to the classification system of Delmas and Chifflet 1950) – both transverse sinuses are present, but only the right one is in continuation with the superior sagittal sinus. Although the absence of the temporal bones and large portions of parietals makes it difficult to visualize the shape of the vault from the rear, the contour is apparently like that of a modern human – somewhat smoothed "*en maison*" shape. There is a well-defined eminence on the right parietal bone.

The morphology of the specimen clearly indicates a modern *H. sapiens*. Moreover, the thick vault bones, along with the robust nuchal region and partial suture closure, suggest a an adult male individual.

• A fragmented human skull from **IlineVode** exhibits of a number of neurocranial elements (Fig. 4). These include: a partial frontal bone; the right posterior fragment of the braincase; and two smaller parietal fragments. The frontal preserves the mid-squamosal region, including the left glabelar region with sinus exposed, and a section of the right half of coronal suture, connected to a narrow band of parietal. The posterior braincase fragment consists of the right half of the occipital squama, the posterior half of the right parietal and a small fragment of the temporal along the parietomastoid suture. The smaller (left?) parietal fragment shows no sutures preserved, while the larger one preserves a part of the lambdoid suture. The middle meningeal grooves are thin and display a modern pattern of ramification. The cranial sutures display deep denticulation and significant closure; there are many small ossicles in the lambdoid suture. All fragments show heavy taphonomic erosion of both tables, with observable (but also eroded) plant root markings. These are not to be confused with traces of small capillary impressions, which are frequent on the

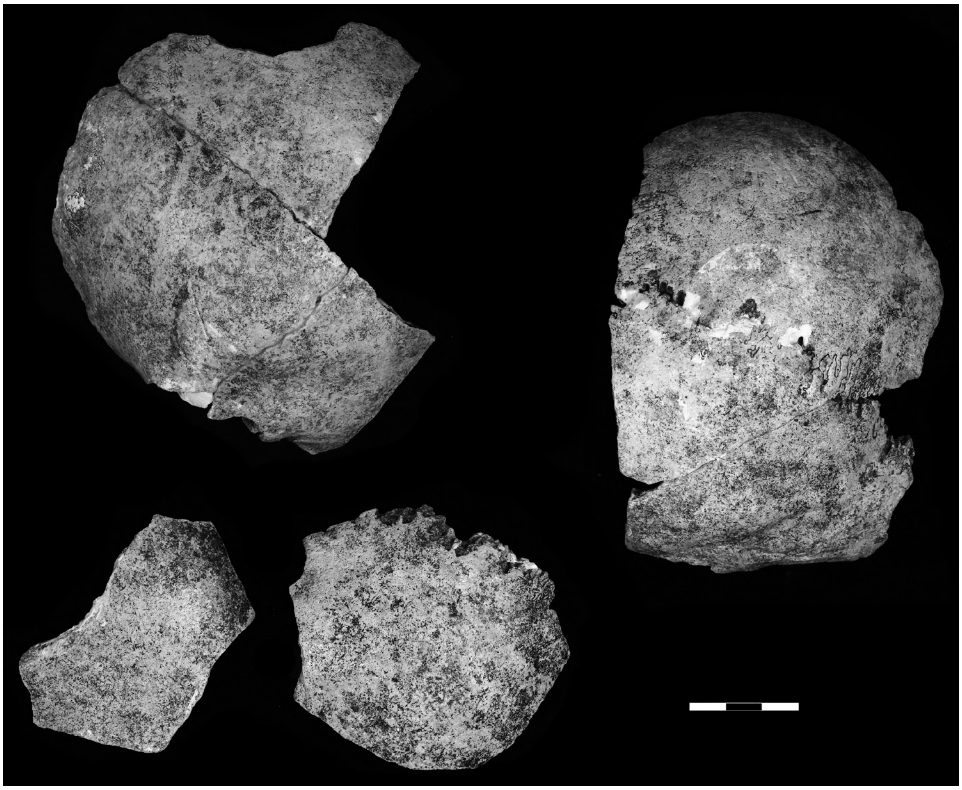

Figure 4. A fragmented skull from Iline Vode.

inner table of the skull; there are studies which suggest that these vascular impressions in older individuals represent healed lesions with different aetiologies (Lewis 2004).

Iline Vode shows no deviations from modern human anatomy. The skull was short and globular, with pronounced parietal and frontal eminences. The glabelar region is smooth and shows only a minimal prominence. The outer surface of the occipital bone is also smooth, with no projecting nuchal crest viewed in lateral profile and with only slight expressions of nuchal lines. On the inner surface of the occipital there is a right dominant asymmetric type 3 sinus drainage pattern (following the classification system of Delmas and Chifflet 1950). Based on the gracile morphology, bone thickness, and suture closure, the specimen most likely was an adult female.

• The **Ostružnica** specimen is represented by the superior half of the left parietal bone, which preserves the occipital angle and significant portions of the lambdoidal and sagittal sutures (Fig. 5). The fragment shows significant post-mortem erosion, especially on the external table of the bone. The bone is not especially thick. Sutures show moderate denticulation and there is no evidence of closure. The curvature of the bone is pronounced, suggesting a large, rounded parietal eminence. The middle meningeal grooves display a complex pattern of ramifications. On the superior inner border, superior sagittal sinus is well defined.

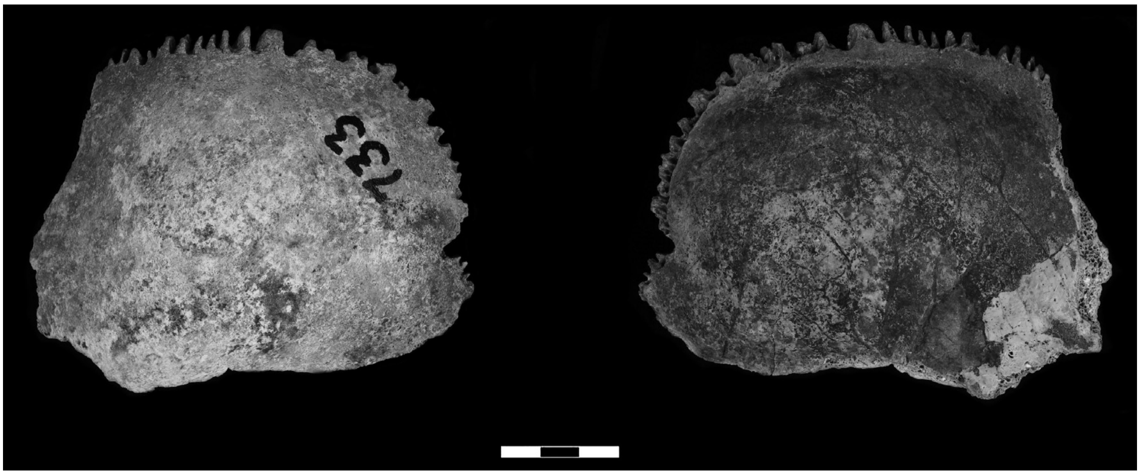

Figure 5. Ostružnica parietal.

Parietal bones of modern humans generally show a high degree of curvature, related to the increase of neurocranial globularity and brain size (Lieberman et al. 2002). Although we could not quantify parietal curvature using the linear diagnostic metric, there is no doubt that Ostružnica fits with modern *H. sapiens* in this regard. Also, the complexity of the middle meningeal arterial network seen in the specimen is very modern, clearly different from the low level of meningeal traces seen in non-modern humans (Bruner et al. 2005). These traits manifestly point to a modern *H. sapiens* designation for Ostružnica specimen. Although there is no suture closure, the thickness of the bone suggests an adult individual.

• The **Kotež** calvaria consists of an almost complete frontal bone joined to small fragments of the parietal bones (Fig. 6). While otherwise very smooth and glassy, the external surface shows weathering damage, mostly on the left portion of the specimen. The internal surface remains without erosion. The color of the specimen is distinctly dark brown. On the frontal, posteromedial portions of the orbital plates are missing, and parts of the sinuses are exposed. A thin crack (about 1mm at its widest) extends from the posterior part of the fragment to the region of the frontal eminences, about 1 cm from the midline. The right parietal fragment is better-preserved showing the complete sphenoidal angle and sections of the temporal lines, while the left fragment only follows the coronal suture as a narrow band of bone extending only medially.

The Kotež specimen is characterized by small size and very modern and gracile morphology. The frontal bone shows a very high and rounded frontal squama with pronounced frontal eminences. Thin superciliary arches are well separated from thin and flat supraorbital trigones, and there is only a slight projection of the glabella in lateral view. The coronal profile of the specimen indicates a broad and smoothly curved top of the skull, with no sagittal keeling. Sinuses do not seem too capacious. The supraorbital margins are very sharp and there are supratrochlear notches on the both sides. The coronal suture is weakly denticulated (running almost without any denticulations on the left medial half), and there is only minimal suture closure. Both temporal lines and parietal striae are clearly observable on the right parietal fragment. On the internal surface of the specimen, there are deep grooves of the anterior branch of the middle meningeal arteries, which are preserved to a greater extent on the right parietal. A few smaller arachnoid pits (less then 0.5 cm wide) are observable both on the frontal and parietals, but there is also one larger pit (1.3 cm wide) connected to the meningeal groove on the left parietal fragment. Small capillary impressions are quite frequent on the inner surface of the calvaria. On the basis of morphology, there is no doubt that the Kotež specimen represents the remains of an adult anatomically modern *Homo sapiens* female. No primitive traits were observed.

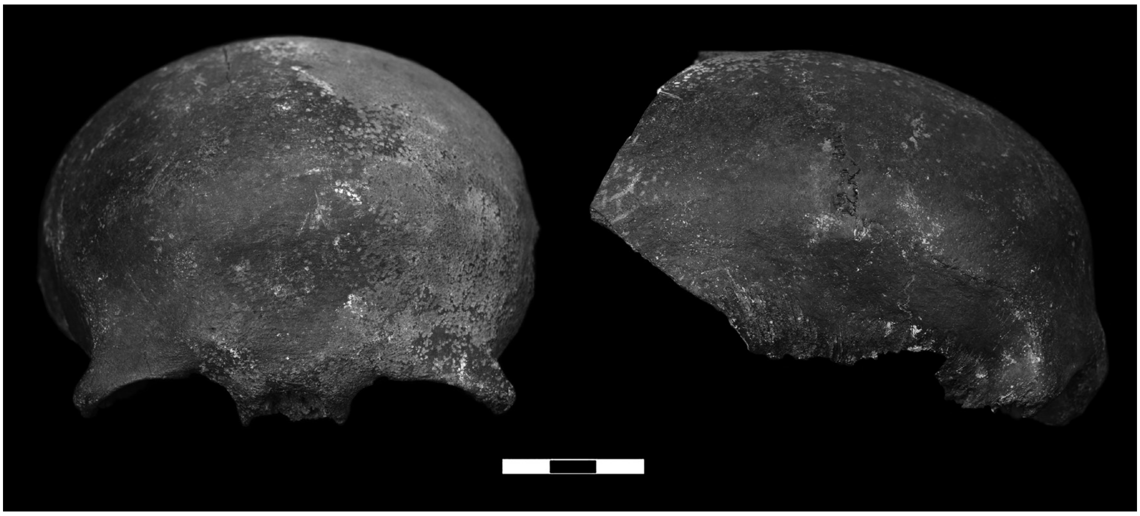

Figure 6. Kotež specimen.

Prescreening results

The percent insoluble fractions of the bones were surprisingly high, more similar to average values from modern bones than those from Pleistocene-age bones (Tab. 1). FTIR spectrometry of the insoluble fractions showed peaks representative of collagen. Some spectra also showed clay peaks, but no evidence of organic contaminants was observed (Fig. 7).

However, glue derived from non-human animal collagen cannot be distinguished from human collagen by FTIR spectrometry of insoluble fractions. Therefore we used Zooarchaeology by Mass Spectrometry (ZooMS) to test for the presence of non-human animal collagen. ZooMS is a method of zooarchaeological identification based on species-specific peptide sequences in bone collagen (Buckley et al. 2008). Bone powder from the surface and interior of all specimens was sent to the BioArCh laboratory at the University of York for ZooMS analysis. The measured peptide markers are consistent with those expected from hominins, and not other mammals used for collagen-based glues (Welker, pers. comm.).

Six specimens have undergone radiocarbon pretreatment procedures for bone collagen. The procedure consisted of acid-base-acid (ABA) treatment, gelatinization, filtration through Ezee-filters and ultrafilters (Vivaspin™ 15-30 kD MWCO) and lyophilization as described by Brock et al. (2010) and Yizhaq et al. (2005). The percent efficiency (Tab. 1) represents the percent by weight of sample that survives pretreatment through lyophilization. It is noteworthy that the samples' percent efficiencies were much lower than their respective %IF, which reflects the

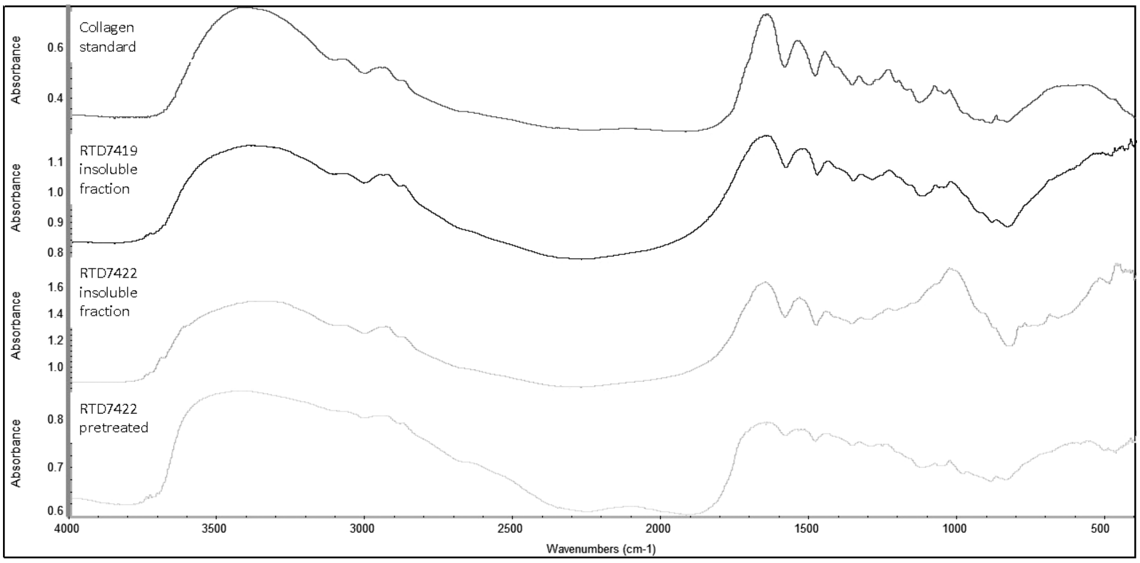

Figure 7: Fourier transform infrared (FTIR) spectra of samples during prescreening and pretreatment. From top: Collagen standard showing diagnostic peaks; insoluble fraction of RTD7419 appears to be pure collagen; insoluble fraction of RTD7422 contains collagen as well as clay peak at 1033cm-1; RTD7422 after full radiocarbon pretreatment shows clay eliminated.

percent by weight that survives acid dissolution in 1 N HCl. The high %IF and lower percent efficiencies suggests that some non-collagenous material or degraded collagen was effectively removed during pretreatment. This pattern increases our confidence that potential contaminants have been removed and the measured radiocarbon dates will reflect the age of the bones.

Radiocarbon dating results

The final dating results, both calibrated and non-calibrated, are shown in Table 1. All of the samples were Holocene aged, ranging from modern to 5450 calBP (95% highest probability density).

Lab ID	Collection	Collection number	Locality	SF	% IF	% eff	%C	14C BP	calBP (95%)
RTD7422	NHMBEO	?	MečijeRupe	3.4	16.4	0.84	42	975 ± 36	950- 800
RTD7389	NHMBEO	204	Kolubara	3	20	0.94	34.4	1003 ± 39	980- 800
RTD7419	NHMBEO	807	?	3	6.7	0.64	42.4	1296 ± 48	1300- 1090
RTD7418	NHMBEO	199	IlineVode	3.1	12	0.26	20.4	4094 ± 97	4850- 4300
RTD7483	NHMBEO	202	Ostružnica	3.1	14.2	0.58	41.2	220 ± 46	<430
RTD7390	NMKV	-	Kotež	2.7	20.1	0.8	41.1	4559 ± 54	5450- 5040

Table 1. Prescreening and AMS radiocarbon dating results for five specimens housed at the Natural History Museum Belgrade (NHMBEO) and one from the National Museum Kraljevo (NMKV).

Discussion and conclusion

All of the specimens presented here show clear modern human morphologies. There are no indications of primitive (non-modern) traits in any of the specimens. The robust nuchal structure seen in the specimen an unknown locality (807) is apparently simmilar to “nuchal tori” of many males in the early Central European Upper Paleolithic (Mladeč, Pavlov etc.) (Frayer et al. 2006). 1 However, this structure should not be overemphasised as the 14C date for the specimen is recent, which shows that the morphology of the nuchal region is simply a reflection of a strong neck musculature.

This modern morphology of the specimens is in accordance with their 14C ages. Although it is disappointing that the measured age of the specimens did not correspond to our expectations based on contextual information, the study was successful in multiple regards. First, the measured radiocarbon ages likely reflect the date of the humans' deaths, rather than artificially younger ages due to modern carbon contamination. By thorough prescreening and chemical characterization we are confident that Pleistocene specimens are not being overlooked due to inaccurate dating. Secondly, the study demonstrates the need for reliable absolute dating to validate age-claims based on documentation and morphological/taphonomic features. Taphonomic characteristic and tenuous recorded association of these specimens with Pleistocene-aged strata and material can not be used as reliable indicators of their true age.

Considering the importance of the Central Balkan Pleistocene human fossil record, our search for undescribed specimens from old museum collections will certainly be continued. However, if indeed we want to understand the early presence of modern humans in the Central Balkans, emphasis will need to be placed on excavations of known and recently discovered Pleistocene sites

Acknowledgments

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[1] While Frayer et al. (2006) use the term "nuchal torus" in their descriptions of the Mladeč AMHs, most authors reserve the term only for a specific projecting transverse bar of bone on sharp-angled occipitals of *H. erectus* and other archaics (Mai et al. 2004: 369). This structure is more robust and differently built in *H. erectus* than corresponding structures in UP humans, so there is the question of whether or not the robust nuchal structures in UP skulls even qualify as a true nuchal tori.

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ESR DATING UNGULATE TOOTH ENAMEL FROM THE MOUSTERIAN LAYERS AT PEŠTURINA, SERBIA

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Abstract: Most Middle Paleolithic sites exceed the maximum ^{14}C dating limit, but electron spin resonance (ESR) can date tooth enamel from ~5-10 ka to > 2 Ma with 2-5% precision. In southern Serbia, Pešturina overlooks a tributary to the Nišava River southwest of Niš near the Sićevo Gorge. Pešturina hosts a series of matrix-supported conglomerates that contain a Charentian Mousterian industry, a Denticulate Mousterian, and a blade-rich Gravettian in Layers 4, 3, and 2 respectively. Fauna in all three layers suggest a mixed environment with temperate forest, rocky cliffs, and steppe within walking distance from the cave. Although hyenas likely contributed some bone to the site, especially in Layer 3, the fragmentation patterns and butchering marks plus the presence of many lithic tools suggest that some faunal remains were human kills. The predominance of horse in the lower layers suggests a warmer and drier climate during the deposition of Layer 4, than during later phases. Although tools from all production stages occurred, the scarcity of cores suggests that their initial manufacture happened elsewhere. From five herbivore teeth found in the Mousterian Layers 3-4b, 24 enamel subsamples were independently dated with ESR. Multiple sediment samples were analyzed by NAA to calculate volumetrically averaged sedimentary dose rates. Although rodents apparently reworked at least one tooth in Layer 4b, three of the teeth appear to be stratigraphic succession and, thus, likely date the layers in which they occurred. If the teeth accurately reflect the ages for the tools in Layers 3-4b, this represents the first site in the Central Balkans with quasi-continuous occupation from 102 ± 5 ka to 39 ± 3 ka. The latter is one of the latest dates for the Middle Paleolithic in Serbia, while the former is one of the few dates for the Middle Paleolithic in the central Balkans correlating with MIS 5.

Key words: ESR dating: ungulate enamel; Mousterian, Pešturina, Serbia

Introduction

Dating sites that have both Middle (MP) and Upper Paleolithic (UP) deposits permits us to test the various hypotheses regarding the Middle-Upper Paleolithic (MP-UP) transition and the Neanderthal's sudden extinction after 300 ky of successful adaptation to northern regions. Unfortunately, the lack of reliable dates for sites near the MP-UP transition makes it almost impossible to reject some hypotheses for the cultural turnover and the Neanderthal extinction that accurate and precise dates otherwise could eliminate. Most Middle Paleolithic (MP) exceed the maximum ^{14}C dating limit, while the few late MP sites that do not exceed that limit often have yielded ^{14}C dates that fail to agree with the stratigraphy for the site in which they were found

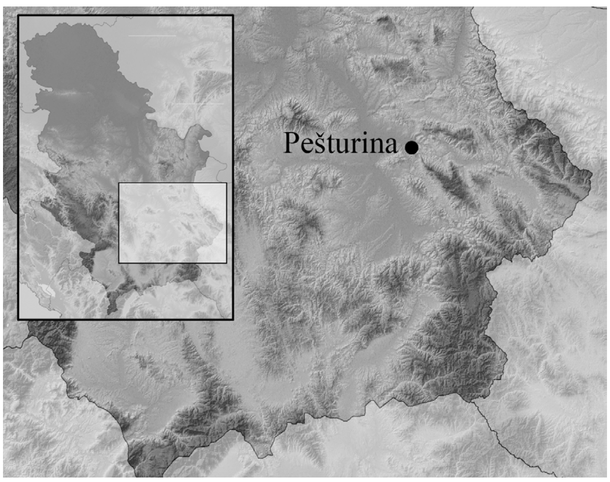

Figure 1. Pešturina Cave, near Jelašnica, Serbia. South of Niš, the cave sits on small hill, overlooking a small tributary to the Nišava River, just at the border between the rocky uplands and the lowlands.

(Conard et al. 2006). That small amounts of modern or ancient ^{14}C contamination can produce large differences in the calculated ^{14}C ages, may explain some of, but not all, these discrepancies. ESR (electron spin resonance) dating, however, can date the Middle Paleolithic sites with 2-5% precision. Ergo, this study dates five herbivore teeth from Pešturina, Serbia (Fig. 1), a site that contains both Middle and Upper Paleolithic tools.

Pešturina sits near a possible migration route for species like *H. sapiens* between Istanbul and Trieste through the Balkans, a route that would also permit technological innovations, like the Upper Paleolithic, to spread from the Middle East into Europe. During Marine Isotope Stage (MIS) 2, Serbia sat within a large Balkan refugium for several species, including possibly Paleolithic humans. Near Pešturina, Mala Balanica yielded an archaic *Homo* sp. mandible, BH-1, dated between 397 and 525 ka (Rink et al. 2013). Despite the long history of human habitation in the area, Paleolithic archaeological evidence from this vast territory remains scarce.

Pešturina Cave

In southern Serbia, Pešturina (literally "cave") sits overlooking a small tributary to the Nišava River at 43˚10' N 21˚54' E, southwest of Niš near the Sićevo Gorge (Fig. 2; Mihailović and Milošević 2012). Today, the area averages 2-4°C in winter, but 18-20°C in summer, with most precipitation falling in winter. The cave also straddles a major migration route from Asia into northern Europe, a route along which cultural or species migration could have occurred in the Middle-Late Pleistocene.

Although the sediment is the thickest at Pesturina's entrance, Pleistocene sediment occurs throughout the cave (Fig. 3). In both Layers 2 and 3, rodents have burrowed extensively. Layer 2 contains a brown, compact silty sand with cryoturbation features, which is lighter in colour than that in Layer 3. Layer 3 contains a sandy silt with small *éboulis*, but fewer than those found in the lower Layer 4. In places, Layer 4's surface was eroded before Layer 3 was deposited. Layer 4a is a reddish brown, lightly compacted, sandy silt, while Layer 4b is browner and richer in clay with more *éboulis*. Layer 4c appears to represent a major roof collapse near the cave entrance, or possibly a bedrock layer that separated two distinct caves. What lies below Layer 4c remains to be discovered as excavation progresses in the cave (Mihailović and Milošević 2012).

Pešturina contains at least two layers with Mousterian tools (Fig. 1) underlying a layer with Upper Paleolithic tools (Mihailović and Milošević, 2012). In Pešturina, Layers 2-4b had > 200 identifiable, well preserved, mammal fossils. In Layer 2, wolf (*Canis lupus*) dominates the carnivores, but hyenas (*Crocuta spelaea*) are more common in Layers 3-4b. Layer 2 also has many horse (*Equus*), aurochs (*Bos primigenius*), and ibex (*Capra ibex*) bones. Layer 3 has more horses, red deer (*Cervus elaphus*), and aurochs than Layer 2, but the bones were badly fragmented. Layer 4 had even more horses and aurochs, plus roe deer (*Capreolus capreolus*), chamois (*Rupicapra rupicapra*), ibex, rhinoceros, and mammoth (*Mammuthus primigenius*). These fauna suggest that near the cave, savannas with horse and aurochs herds, temperate forest with red and roe deer (*Capreolus capreolus*), and rocky cliffs with ibex and chamois all existed within walking distance. Although hyenas likely contributed some bone to the site, especially in Layer 3, the very large animal ramains, like rhino and mammoth, plus the lithic tools indicate that some faunal remains were human kills. The high percentages of horse in the lower layers suggest that the climate was warmer and drier during the deposition of Layer 4, than later in Layers 3 and 2 (Mihailović and Milošević 2012).

Layer 4 contains a Charentian Mousterian tool assemblage with > 100 lithic tools, ranging from sidescrapers to burins. Most were made on quartzite, mainly using a centripetal reduction pattern that creates thick pseudo-Levallois or *éclat débordant* flakes. Often, these tools were used as naturally backed knives (*couteaux à dos naturel*), or as blanks for sidescraper production. Although tools from all production stages occurred, cores were scarce, suggesting that occupants brought most tools to the cave after their initial manufacture elsewhere (Mihailović and Milošević 2012).

Layer 3 yielded somewhat fewer tools than the other layers. A typical Denticulate Mousterian industry, this deposit had more notches and denticulates, but no sidescrapers. Just like Layer 4, Layer 3 contains numerous flakes, but few cores (Mihailović and Milošević 2012).

In Layer 2, ~ 100 chipped tools with a flake:blade ratio near 1.0 indicates a Gravettian industry. Most were made on flint or chalcedony. Backed pieces, retouched blades, and flakes were more common than awls or scrapers (Mihailović and Milošević 2012).

Although ^{14}C dates have been attempted for Layers 2-4 (Alex and Boaretto, this volume), the great spread in those ages for any one geological layer suggests that major sample reworking has affected each layer, that modern carbon contamination may have affected some samples, or that the samples actually exceed the maximum ^{14}C dating limit. This study dated tooth enamel from five ungulate teeth with electron spin resonance (ESR).

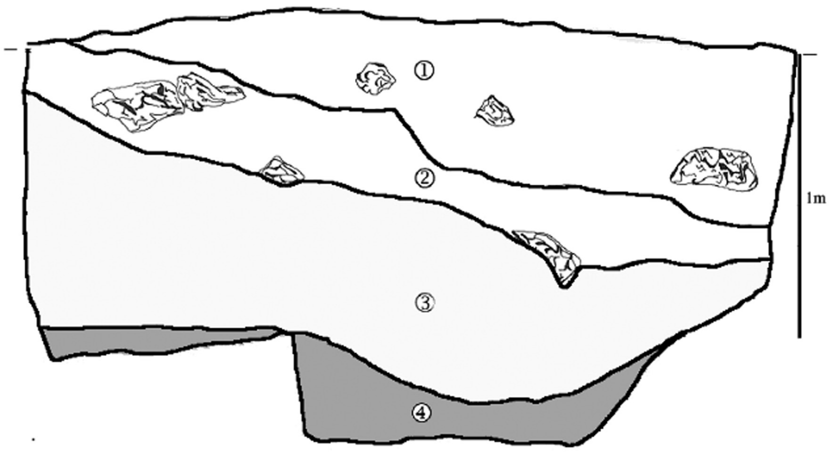

Figure 2. The stratigraphy at Pešturina, Serbia.
Five archaeologically or geologically distinct layers of matrix-supported conglomerates have been identified. Rodents have burrowed extensively in Layers 2 and 3 (adapted from Mihailović and Milošević 2012).

Electron Spin Resonance (ESR) Dating

ESR dating uses signals from single electrons trapped in crystal lattice defects in the hydroxyapatite (HAP) in enamel. When minerals absorb energy from natural radiation (α, *β*, or γ) from the cosmos, the surrounding sediment, dentine, and enamel, the single electrons trapped at crystal lattice defects accumulates over time. Normally, electrons are paired and cancel each other's magnetic field, but the unpaired electrons trapped in the crystalline defects produce a magnetic field detectable by an ESR spectrometer. The more radiation that the mineral absorbs, the more electrons are trapped, as the ESR signal grows proportionally with the number of trapped charges at a given lattice site. After the peak height reaches saturation, i.e., when the traps have all filled trapped electrons, the ESR signal can no longer grow, even if radiation is added. This sets the maximum ESR dating limit. The ESR spectrometer's ability to distinguish the sample's signal from the background noise sets the minimum dating limit. Low radiation dose rates mean older minimum and maximum age limits, while high radiation dose rates mean relatively recent dating limits (Blackwell 2006).

For reliable ages, the signal lifetime, τ, must exceed the sample's age by > 2-3 orders of magnitude. For the HAP signal at $g = 2.0018$, the signal used for dating tooth enamel, $\tau \sim 10^{19}$ y at 25°C (Skinner et al. 2000). The HAP signal only zeroes at > 300°C. Recrystallization changes the HAP signal's shape, but not its age (Skinner et al. 2001). Thus, this very stable HAP signal can be used to date vertebrate tooth enamel from 5-10 ka to 2-4 Ma in age, usually with 2-5% precision

(Blackwell 2001, 2006). If the HAP peak height can be converted into an absorbed radiation dose, A_{Σ}, an ESR age can be calculated from (Blackwell et al. 2013):

$$\mathcal{A}_{\Sigma} = \mathcal{A}_{\text{int}} + \mathcal{A}_{\text{sed}} + \mathcal{A}_{\cos} = \int_{t_0}^{t_1} D_{\Sigma}(t)\,\mathrm{d}t = \int_{t_0}^{t_1} (D_{\text{int}}(t) + D_{\text{sed}}(t) + D_{\cos}(t))\,\mathrm{d}t \tag{1}$$

where

$\mathcal{A}_{\Sigma}$ = the total accumulated dose in the sample,
$\mathcal{A}_{\text{int}}$ = the internally derived accumulated dose component,
$\mathcal{A}_{\text{sed}}$ = the externally derived accumulated dose component from sedimentary sources,
$\mathcal{A}_{\cos}$ = the externally derived accumulated dose component from cosmic radiation sources,
$D_{\Sigma}(t)$ = the total dose rate,
$D_{\text{int}}(t)$ = the total dose rate from internal sources: U, its daughters, and other radioisotopes,
$D_{\text{sed}}(t)$ = the total dose rate from the external environment: sedimentary U, Th, and K,
$D_{\cos}(t)$ = the total dose rate from the external environment: the cosmic dose,
t_1 = the sample's age,
t_0 = today.

To find the accumulated dose, A_{Σ}, an enamel subsample is split into 10-15 aliquots. In the additive dose method, after the aliquots have been irradiated with increasing, precisely known, added radiation doses from a ^{60}Co γ source, the ESR peak heights are measured. Graphing the peak heights *vs*. the added dose gives a line with an *x*-intercept that equals A_{Σ}. The internal dose rate, $D_{\text{int}}(t)$, comes from U and its daughters within the sample (e.g., Table 2). The U concentration, $[U_{\text{en}}]$ and $[U_{\text{den}}]$, can be measured by neutron activation analysis (NAA). Since U, Th, and K in the sediment surrounding the sample primarily produce the sedimentary dose rate, $D_{\text{sed}}(t)$, NAA is also used to measure their concentrations (e.g., Table 3; Blackwell 2006). The cosmic dose rate, $D_{\cos}(t)$, is modelled from the tooth's stratigraphic history (Deely et al. 2011).

Because live teeth lack U, but fossil teeth can contain high U concentrations, some ESR enamel age calculations require an U uptake model, *p*, to calculate internal dose rate, $D_{\text{int}}(t)$. Since the three dental tissues absorb U at different rates, the U uptake rates for each tissue, *p*, should be measured with coupled ESR-^{230}Th/^{234}U dating, if $[U_{\text{en}}] > 1$ ppm or $[U_{\text{den}}] > 5$ ppm. Three U uptake models can also delimit the age spread: Since the Early U uptake (EU) assumes that the tooth absorbed all its U right after its burial, it gives the minimum possible age. Linear U uptake (LU) assumes constant uptake throughout the sample's burial history to yield a median age. Recent U uptake (RU) assumes that the sample absorbed most of its U recently sets the maximum possible age. The spread between the three model ages depends strongly on the U concentrations within the tooth. The LU model usually gives the most reliable ages for teeth in the age range from 50 to 500 ka, when compared to ages determined by other models (Blackwell 2001, 2006; Blackwell et al. 2014). For teeth like those from Pešturina, however, the low U concentrations (Table 2) mean that coupled ESR-^{230}Th/^{234}U analyses will not be necessary and that the three model ages do not differ significantly. Also, little U means little Rn and radon loss. Thus, in the Pešturina teeth, the low enamel and dentinal U concentrations make these potential sources of error insignificant compared to other sources of error in the age calculation.

$D_{\text{sed}}(t)$, the sedimentary dose rate, was measured using NAA. In sediment, α's can penetrate 20 μm, β's, 2-3 mm, and γ's, 30 cm. In most archaeological sites, including Pešturina, the sediment occurs as thinly bedded, mineralogically (i.e., geochemically) inhomogeneous layers. Since each sedimentary mineral emits radiation at a different rate, measuring an accurate $D_{\text{ext}}(t)$ requires volumetric analysis, in which the contribution from each sedimentary component is weighted by its volumetric abundance with the 2-3 mm for β particles or 30 cm for γ radiation around the tooth, in order to calculate a volumetrically averaged sedimentary dose rate produced by the β particles, $\overline{D}_{\beta,\text{sed}}(t)$ and that created by γ radiation, $\overline{D}_{\gamma,\text{sed}}(t)$ (Blackwell and Blickstein, 2000). In practical applications for tooth enamel from archaeological sites, one or two sedimentary units and possibly up to three different mineralogical clast types typically generate $\overline{D}_{\beta,\text{sed}}(t)$ Due to the larger sediment volume over which $\overline{D}_{\gamma,\mathrm{sed}}(t)$ is derived, cases with more than 10 mineralogical clast types or sedimentary units may generate $\overline{D}_{\gamma,\mathrm{sed}}(t)$ (Blackwell et al. 2014).

Water attenuates incident radiation, decreasing the sedimentary radiation reaching the sample. Since Pešturina is part of a karst system, sedimentary water concentrations, W_{sed}, could change if the karst plumbing system changed. Changes in the rainfall or humidity within the cave could also change W_{sed}, which alters $D_{sed}(t)$. To correct for these variations, a time-averaged $\overline{W}_{sed}$ and a time-averaged $\overline{D}_{sed}(t)$ are usually calculated using ramped box modelling protocols (see Deely et al. 2011). Consequently, modern sedimentary water concentrations were measured for Pešturina (Table 4). If a small pothole does exist under Layer 4b at Pešturina in the K8-L11 region, this may require more complex modelling for the water concentration changes with time that was used here.

The cosmic radiation dose rate, $D_{cos}(t)$, depends on the thickness and type of material, where water, clastic or carbonate sediment, covering the tooth. Since teeth in caves are often buried below > 20 m combined sediment cover and roofrock, as is the case for Pešturina (Mihailović and Milošević 2013), $D_{cos}(t)$ is negligible (Blackwell 2006).

After a tooth has been reworked by sedimentary processes or animals, such as the rodents that have burrowed at Pešturina, the sample experiences a different $D_{sed}(t)$ and $D_{cos}(t)$, since it is now surrounded by different sediment and likely sitting at a different depth in the sediment compared to its original position. To test if reworking has occurred 4-5 teeth per layer are dated. If all the teeth give similar U concentrations, accumulated doses, and ages, it is less likely that they have been moved after their original deposition (Blackwell 1994).

Analytical Method

Using the standard ESR procedures for enamel and working in a Class 10,000 clean lab, 10 teeth were prepared from Pešturina. To prevent contamination, all glass and plasticware were rinsed once with 6 M HCl(*aq*) and then > 15 times with doubly distilled deionized water to remove the Cl^- ions (Blackwell 1989).

After drawing and photographing each tooth from 4-6 views, in order to retain a visual record after it was destroyed, the dentine and enamel thicknesses were measured in 10-20 places with a digital CD-4C calliper. After subdividing each tooth into 3-8 subsamples by a hand-held diamond-tipped Dremel drill, all the dentine was drilled off the enamel surface and saved for NAA. After the thickness of each enamel was measured in 20-50 spots using a Mitutoyo ID-C112E micrometer with an automatic data recorder, 20 μm was shaved off both surfaces to remove the enamel affected by α radiation to simplify $D_{int}(t)$ calculations. After powdering the enamel to 150-74 µm (200-400 mesh) with an agate mortar and pestle, 20.0 ± 0.1 mg of enamel was weighed into each of 14-16 aliquots and any remaining enamel was saved for NAA. All aliquots, except one (the 0 dose), were irradiated using a ^{60}Co γ source with doses from 0-256 krad at 16.0-18.0 krad/s, and annealed at 90°C for 3.0 days to remove any unstable interference created by the irradiation.

All aliquots' ESR spectra were analyzed in a JEOL RE1X spectrometer at 2 mW power under 100 kHz field with a modulation amplitude of 0.1 mT. The spectra was scanned at 336.0 mT using an 8.0 minute sweep time and 0.1 second time constant with receiver gain set to maximize peak heights. With EWWIN v. 4.5, derivative spectra were collected, stored, and measured without deconvolution, because the two HAP signal components follow identical growth (Skinner et al. 2001).

The samples' water loss was analyzed by measuring each sediment sample's initial mass and drying it on a hot plate for 6-10 days, while measuring the mass change each day. When the sample's mass stops changing, change in mass was used to calculate the water loss. The water loss was then averaged for the unit as a whole.

For NAA, after powdering the sediment, enamel and dentine to 50-200 mesh, ~ 0.7 g of sediment and > 1.0-1.5 g of powdered enamel and dentine for each subsample were analyzed by NAA.

For U, delayed neutron counting for 60 s followed a 60 s irradiation and a 10 s cooling delay. One enamel and one dentine per tooth, and all sediment samples were counted for K for 20.0 minutes using a γ counter after a 60 s irradiation and 24-30 hr. delay, and for Th, after a 1.0 hr. irradiation, and a 7-10 day delay. Results were standardized to NIST standard 1633B (Blackwell 2006).

Data and Error Analyses

By plotting the ESR peak heights against the added dose, A_{Σ}, and its errors were calculated using Vfit by assuming a saturating exponential fit weighted by $1/I^2$. Rosy *v*. 1.4.2, which corrects β and γ attenuation, but not α, due to the water concentration, tissue density, and thicknesses from sediment and tissues, was then used to calculate the ages, dose rates, and their errors for all subsamples (Brennan et al. 1997). The α/γ efficiency factor was set to 0.15 ± 0.02 (Grün 1989), and the initial $({}^{234}U/{}^{238}U)_0$ ratio, 1.20 ± 0.02 (Blackwell 2001). Volumetrically averaged $\overline{D}_{sed}(t)$ were calculated by averaging dose rates from all adjacent units, weighted by their volume within the 30 cm γ sphere of influence as determined in the field, from the total station data, and from site photographs. Time-averaged cosmic dose rates were calculated using ramped box models (Deely et al. 2011). The weighted mean ages were calculated by weighting the samples' ages by the inverse of their errors. In the interlaboratory calibrations (e.g., Barabas et al. 1993; Wieser et al. 2005), ESR ages produced in the Williams College labs did not show systematic errors. Normally, uncertainty in $D_{sed}(t)$, $D_{cos}(t)$, and A_{Σ} add about 2-5% uncertainty to the final ESR ages. Their accuracy depends on the spectrometer's calibration, the radiation source calibration, the sample's age and diagenetic state. The McMaster Nuclear Rector ${}^{60}Co$ γ source is calibrated biennially against the NRC standard source (Blackwell 2006).

Results

From Pešturina, 24 subsamples from one ibex, one deer, one rhinoceros and two equid teeth were each dated independently with standard ESR (Table 1).

In order to analyze $D_{sed}(t)$, 24 bulk sediment samples were analyzed by NAA (Table 3), while 69 bulk sediment samples were tested for their water concentrations (Table 4). The bulk sediment analyses from each layer gave relatively consistent water and elemental concentrations. For the bulk sediment samples, mean $D_{sed,\beta}(t)$ values averaged from 0.261-0.340 ± 0.51-0.57 mGy/y, and $D_{sed,\gamma}(t)$, from 0.548-0.666 ± 0.085-0.119 mGy/y. With its low U, Th, and K concentrations, the *éboulis* yielded mean rates of $D_{sed,\beta}(t) = 0.082 \pm 0.016$ mGy/y and $D_{sed,\gamma}(t) = 0.195 \pm 0.032$ mGy/y (Table 3). Since the *éboulis* occurred as large lumps near some teeth, the *éboulis* concentrations for each layer as determined from field observations, total station data, and site photos were added as a separate component into the spherical volumetric analyses around each tooth.

After having been collected on site, where the excavation had exposed all the layers tested for > 1.0 y, allowing them to dry somewhat, 83 sediment samples were tested for water as described above. The modern sedimentary water concentrations ranged from 10 to 14 ± 4-6 wt% (Table 4). Given the clay abundances in some samples, however, drying them fully, even after heating for > 10 days, was impossible. Thus, the modern measurements likely represent a minimum for the modern water concentrations. Hence, to calculate the ages, the time-averaged water concentration, $\overline{W}_{sed}$, was assumed to be 20 ± 5 wt%.

To determine $D_{int}(t)$, 22 enamel and dentine U analyses were completed (Table 2). In all the teeth, the enamel U concentrations averaged ≤ 0.2 ppm, while the dentine U's all averaged ≤ 3.5 ppm. Tissues with such low U concentrations do not produce enough Rn for Rn loss to affect the age accuracy. Since no significant differences exist between the different model ages, and ${}^{230}Th/{}^{234}U$ dates would not yield ages due to the low U concentrations, coupled ESR-${}^{230}Th/{}^{234}U$ dates were not attempted. Since the LU model represents the median age, those values will be used in the following discussion, although Table 5 reports all three model ages for completeness.

Some samples had been wrapped in Al foil, which contained high U. At U = 16.10 ± 0.02 ppm, the tinfoil had considerably more U than any sample yet measured (Table 3). If the tooth or associated sediment had absorbed U from the Al foil, this would present a potential source of error in the calculations. The consistency between samples wrapped in tinfoil and those not so wrapped suggests that none of the dental tissues samples yet measured appear to have absorbed any U from the Al foil (Table 2).

In Layer 3, AT23, aka 2012PES46, yielded six subsamples. Its individual LU ages ranged from 32.3 ± 5.0 to 48.0 ± 7.6 ka. When weighted inversely by their errors and with all subsamples, AT23 averaged 38.9 ± 2.5 ka (Table 5a). Removing AT23en4 from the mean produced an age of 37.2 ± 2.3 ka, which does not differ significantly from the age with all samples. With only one tooth dated from this layer, and evidence for rodent burrows within the layer (Mihailović and Milošević 2012), at least 3-4 more teeth need to be dated from this layer to ensure that this actually represents the age for the deposit rather than that for one reworked tooth. If AT23 has not been reworked, Layer 3 dates to 39 ± 3 ka, which would correlate with mid-MIS 3, with a period of great climatic variation in southern Europe (Barron et al. 2003). This mean age also agrees within errors with the ^{14}C ages for Layer 3 (Alex and Boaretto, this volume). In OIS 3, the climate fluctuated rapidly from warm to cold and back within intervals of ~ 1-2 ky. During the Hengelo Interstadial, at ~ 39 ka, summer temperatures were similar to today, but winter temperatures averaged below 0^{o}C, with 50-70 cm of snowfall (Barron et al. 2003). The heavily fragmented bones found in Layer 3 suggest the cave occupants spent more effort to extract the bone marrow, which is a high energy food source ideal for surviving harsh winters. The lower numbers of horse also hint that climates were cooler in Layer 3 than in Layer 4. If this age is correct, it suggests that the Mousterian peoples (i.e., likely Neanderthals) in this area survived until the Hengelo Interstadial at 39 ± 3 ka.

In Layer 4a, AT22, aka 2012PES50a, gave eight subsamples. Unfortunately, the A_{Σ}'s, which ranged from 39.99 ± 1.50 to 58.54 ± 2.74 Grays, and the LU ages, which ranged from 77.8 ± 12.2 to 114.9 ± 18.4 ka, with a weighted mean of 92.9 ± 5.2 ka, both showed considerable scatter (Table 5b). An isochron analysis on AT22 did not produce results, thanks to its low U concentrations. Discarding either of the two extreme values, AT22en1 or AT22en3, did not significantly change the calculated mean age by more than 2-3 ky, suggesting that this mean age is relatively robust. With only one tooth dated from this layer, however, at least three more teeth need to be dated from this layer to check for possible reworking. This age greatly exceeds the single ^{14}C age for this layer (Alex and Boaretto, this volume), suggesting that reworking cannot be discounted in Layer 4a. If the tooth has not been reworked, Layer 4a dates to 93 ± 5 ka, which would correlate with MIS 5c, a very warm period in southern Europe (Barron et al. 2003). This agrees with the higher percentages of horse plus *Ibex* and rhino seen in Layer 4a that indicate a warmer climate than that later in Layers 2 and 3 (Mihailović and Milošević 2012). Other European sites have also yielded Mousterian tools at this time (e.g., Turk et al. 2002, 2003; Musil 2003; Blackwell et al. 2007, 2008). Thus, this age presents no archaeological surprises.

Layer 4b is a classic "lumpy" layer, with *éboulis* occupying up to 50-60% of the total sediment volume. Some "lumps" occupied > 1.0 m^3. Thus, its volumetrically averaged sedimentary dose rate, $\overline{D}_{sed}(t)$ ranged from 265 ± 43 to 432 ± 68 μGy/y (Table 2), as is typical in "lumpy" sites. Three teeth from Layer 4b were dated, AT24, AT32, and AT36.

A milk molar from Layer 4b, AT24 yielded one subsample, which gave an age 103.5 ± 14.8 ka (Table 5c). Stratigraphically, this age agrees well with those for AT22 above in Layer 4a and AT32 just below in Layer 4b.

With eight subsamples, AT32 yielded ages ranging from 91.3 ± 13.8 to 119.1 ± 18.1 ka (Table 5d), with a mean age of 101.9 ± 3.8 ka. Recalculating the mean without AT32en6 did not produce a significant change in the age. This mean age does agree stratigraphically with the ages for AT22 and AT24.

With only one subsample, AT36 yielded an age of 67.0 ± 9.5 ka (Table 4). Its age appears to be much too young for Layer 4b, given the ages for AT32 and AT22. The erosional contact between Layers 3 and 4a hint that other layers may have once existed between these two, or may exist in unexcavated parts of the cave closer to the walls. Therefore, AT36 was likely reworked from elsewhere. Thus, Layer 4b likely contains at least one reworked tooth. To confirm this, however, at least 3-5 more teeth from Layer 4b need to be dated. If AT24 and AT32 have not been reworked, Layer 4b averages to 102.1 ± 5.2 ka, which would correlate with MIS 5c, a fairly warm, humid period in southern Europe. The faunal analyses are consistent with an age in MIS 5 for this layer (Mihailović and Milošević 2012). Moreover, since the cave excavation is still progressing, newly discovered layers, such as a potential Layer 5 or the cave floor sitting below Layer 4b may affect $\overline{D}_{sed}(t)$ for any tooth sitting within 30 cm of that next lower layer or the floor. Until the excavation reaches that layer, these questions cannot be answered. If the ages for AT24 and AT32 accurately represent the age for the layer in which they was found, that age agrees well with the ages for other Mousterian deposits across Europe (see references in Musil 2003).

Clearly in this lumpy site, getting the volumetric sedimentary analyses correct Layer 4b had lower $\overline{D}_{sed}(t)$ than the other layers due to the limestone *éboulis* found there. To test the effect of inaccuracy in the $\overline{D}_{sed}(t)$ on the calculated ages, ages were recalculated for several teeth with $\overline{D}_{sed}(t)$ values from 200-700 μGy/y. Such analyses showed that changes in $D_{sed}(t) < 100$ μGy/y will produce insignificant changes in the calculated ages.

Dating teeth from lumpy sites is tricky, because the mineralogies, each with their own $D_{sed}(t)$, surround the teeth in different orientations. Therefore, the positions for all teeth need to be checked with the total station data which records the position for all the *éboulis* near the teeth, to provide more accurate $\overline{D}_{sed}(t)$ determinations.

To address the issues of reworked teeth, another five teeth have been prepared and partially analyzed. When finished, these new dates should clarify how much reworking has occurred within the site and permit a more accurate depositional history to be determined.

Conclusions

The ages reported here are the first ages reported for Pešturina Cave, Serbia. Until more teeth can be dated, the problems of potential reworking and possible inaccuracies from the "lumpy" nature of the sediment make it uncertain if the ages actually give accurate ages for the layers in which the teeth were found. If AT22, AT24, and AT32 have not been reworked, Layer 4a dates at 93 ± 5 ka, and Layer 4b, at 102 ± 5 ka, which correlate with MIS 5d-5c, a relatively warm stage, when southern Serbia would have experienced no snow.

If the tooth in Layer 3 was found *in situ*, Layer 3 dates to 39 ± 3 ka. This is one of the latest dates reported for Mousterian cultures in southern Europe (see Musil 2003), but agrees well with the dates at Divje Babe I cave in Slovenia, where the transition from Mousterian to Aurignacian dated at ~ 37 ka (Turk et al. 2002, 2003; Blackwell et al. 2007, 2008). Thus, Layer 3 at Pešturina likely correlates with a short-lived slightly warmer phase between the Hengelo and Les Cottés Interstadials within Dansgaard-Oeschger Event 9-10, or with either the Hengelo and Les Cottés Interstadials themselves. At Divje Babe I, Slovenia, Layers 4-5a (i.e., event DB2), which contain the final Mousterian deposits found in Divje Babe I, was correlated with the same the cold, humid phase between the Hengelo and Les Cottés Interstadials (Dansgaard et al. 1993; Weissmüller 1997; Blackwell et al. 2007, 2008).

Thus, these ages for Pešturina suggest that Mousterian cultures had arrived in southern Serbia by at least 102 ka, and persisted in southern Europe until at least 39 ka. Therefore, either the Balkans served as a refugium for the Mousterian peoples, allowing that culture to persist there later than at other places in Europe. Alternatively, the dates for other transitional site, which were mainly dated by ^{14}C, may not have been calibrated well to compensate for the highly variable ^{14}C production rates during mid-late MIS 3.

To complete this study, more tooth samples from each layer needs to be dated to check for reworking. Since Pešturina is a "lumpy" site with many different sedimentary components, the sedimentary doses may need to be recalculated to increase their accuracy based on the total station data. Studying the events that surrounded Middle-Upper Paleolithic Transition in the central Balkans will elucidate the settlement patterns during MIS 5-3 and provide a better understanding about what drove the Neanderthals to extinction and what precipitated the MP-UP Transition.

Table 1. Samples in the Study.

Number		Location						Tooth	
ESR	Catalogue	Layer	Square	N (cm)	W (cm)	Z (cm)	Elevation (m)	Species	Type
AT23	2012PES46a	3	L9c	0.3	79.9	101.0	303.570	*Capra ibex*	molar
AT22	2012PES50a	4a	M10d			134.0	303.240	*Equus* sp.	cheek
AT24	2012PES28a	4b	I14d	34.4	23.2	118.6	303.394	equid	milk molar
AT32	2012PES51a	4b	M10d	34.5	98.0	182.7	302.753	*Equus* sp.	cheek
AT36	2012PES48a	4b	M10a	43.9	91.2	190.6	302.674	rhinoceros	cheek

Table 2. Sedimentary Radioactivity at Pesturina.

Sample	Location			Concentrations			Dose Rates[1]	
NAA	Layer	Square		[U]	[Th]	[K]	$D^{\mathrm{BG}}_{\mathrm{sed},\beta}(t)$[2]	$D^{\mathrm{BG}}_{\mathrm{sed},\gamma}(t)$[3]
Type				(ppm)	(ppm)	(wt%)	(mGy/y)	(mGy/y)
2012PES11	2	O11		2.12	4.16	1.12	0.315	0.568
bulk sediment			±	0.02	0.28	0.03	0.053	0.079
2012PES27	2	I14d		2.42	4.98	0.91	0.290	0.508
bulk sediment			±	0.02	0.11	0.03	0.050	0.080
2012PES51b	2	M10d		1.87	4.37	0.92	0.269	0.516
bulk sediment			±	0.02	0.29	0.03	0.045	0.071
2012PES54	2	M9d/M8c		2.97	5.06	1.06	0.289	0.688
bulk sediment			±	0.02	0.31	0.03	0.048	0.092
2012PES55	2	M9d/M8c		3.69	4.59	0.86	0.276	0.675
bulk sediment			±	0.02	0.31	0.02	0.045	0.092
Mean	2			2.61	4.63	0.97	0.261	0.602
(*n* = 5)			±	0.73	0.39	0.12	0.052	0.107
2012PES43	3	M9a/L9d		3.04	3.51	0.81	0.243	0.565
bulk sediment			±	0.02	0.23	0.02	0.041	0.079
2012PES44	3	M9b/L9c		3.45	3.51	0.88	0.267	0.614
bulk sediment			±	0.02	0.23	0.02	0.044	0.085
2012PES45b	3	L9c		2.46	4.17	1.01	0.267	0.578
bulk sediment			±	0.02	0.27	0.03	0.043	0.080
2012PES46b	3	L9c		2.93	5.92	1.00	0.330	0.688
bulk sediment			±	0.02	0.38	0.03	0.055	0.096
2012PES53	3	M9a/M8b		3.76	5.87	1.00	0.308	0.760
bulk sediment			±	0.02	0.39	0.03	0.051	0.105
2012PES56	3	L9d/M9a		3.28	3.77	1.00	0.282	0.632
bulk sediment			±	0.02	0.27	0.03	0.047	0.087
2012PES57	3	L9d/M9a		1.63	5.33	0.54	0.165	0.462
bulk sediment			±	0.02	0.23	0.02	0.027	0.064
2012PES58	3	L9c/M9b		2.96	5.39	1.16	0.307	0.700
bulk sediment			±	0.02	0.35	0.03	0.051	0.097
2012PES59	3	L9c/M9b		3.60	4.74	1.21	0.331	0.739
bulk sediment			±	0.02	0.31	0.03	0.055	0.102
2012PES80	3	L9c/K9c		3.68	6.06	0.92	0.342	0.745
bulk sediment			±	0.02	0.38	0.03	0.057	0.103
2012PES81	3	L9c/K9c		3.46	5.91	1.03	0.304	0.741
bulk sediment			±	0.02	0.39	0.03	0.050	0.103
2012PES82	3	L9c/K9c		3.30	6.64	1.08	0.311	0.765
bulk sediment			±	0.02	0.43	0.03	0.051	0.106
ET9sed	3	L9c		-[3]	4.68	0.95	-	-
attached sed.			±	-	0.17	0.02	-	-
Mean	3			3.13	5.07	0.97	0.279	0.666
(*n* = 12)			±	0.60	1.09	0.17	0.057	0.119
2012PES50b	4a	N10d		2.88	4.66	1.10	0.340	0.652
			±	0.02	0.30	0.03	0.056	0.091
Mean	4a			2.88	4.66	1.10	0.340	0.652
(*n* = 1)			±	0.02	0.30	0.03	0.056	0.091

... continued

Sample	Location			Concentrations			Dose Rates[1]	
NAA	Layer	Square		[U]	[Th]	[K]	$D^{BG}_{sed,\beta}(t)^2$	$D^{BG}_{sed,\gamma}(t)^3$
Type				(ppm)	(ppm)	(wt%)	(mGy/y)	(mGy/y)
2012PES28b	4b	I14d		2.18	3.58	0.76	0.244	0.482
bulk sediment			±	0.02	0.10	0.02	0.042	0.066
2012PES29	4b	I14		3.05	3.66	0.92	0.306	0.592
bulk sediment			±	0.02	0.11	0.03	0.052	0.081
2012PES30	4b	I14		2.27	4.18	0.87	0.272	0.535
bulk sediment			±	0.02	0.12	0.02	0.046	0.073
2012PES31	4b	I14		2.38	5.38	1.06	0.319	0.629
bulk sediment			±	0.02	0.12	0.03	0.053	0.086
2012PES32	4b	I14		2.25	3.56	0.85	0.264	0.504
bulk sediment			±	0.02	0.10	0.02	0.045	0.069
2012PES40	4b	M10c		2.29	4.30	0.86	0.271	0.539
bulk sediment			±	0.02	0.27	0.02	0.045	0.074
2012PES41	4b	M9b		2.41	4.88	0.98	0.302	0.596
bulk sediment			±	0.02	0.31	0.03	0.051	0.082
2012PES42	4b	M10a		2.09	4.00	0.82	0.255	0.502
bulk sediment			±	0.02	0.27	0.02	0.043	0.070
2012PES47b	4b	N9a		2.86	4.37	1.00	0.319	0.619
bulk sediment			±	0.02	0.27	0.03	0.054	0.085
2012PES48b	4b	M10a		2.10	4.23	0.93	0.278	0.533
bulk sediment			±	0.02	0.28	0.03	0.048	0.074
2012PES85	4b	I14d		2.11	4.23	0.74	0.242	0.498
bulk sediment			±	0.02	0.27	0.02	0.041	0.069
ET5sed[4]	4b	N9a		2.76	5.72	1.21	0.364	0.705
attached sed.			±	0.02	0.27	0.03	0.061	0.098
Mean	4b			2.36	4.22	0.89	0. 279	0.548
(n = 6)			±	0.32	0.55	0.10	0. 051	0.085
2012PES83	nonporous roofrock			1.43	0.75	0.10	0.074	0.176
bulk sediment			±	0.02	0.07	0.00	0.013	0.024
2012PES84	porous roofrock			1.34	1.49	0.17	0.088	0.211
bulk sediment			±	0.02	0.11	0.01	0.014	0.030
Mean *éboulis*	roofrock			1.39	1.12	0.14	0.082	0.195
(n = 2)			±	0.04	0.37	0.04	0.016	0.032
2012PES49	tinfoil			16.10	0.45	0.07	0.579	1.460
bulk sediment			±	0.02	0.06	0.00	0.093	0.200

1 Abbreviations: $D^{BG}_{sed,\beta}(t)$ = bulk sedimentary dose rate from β sources
$D^{BG}_{sed,\gamma}(t)$ = bulk sedimentary dose rate from γ sources
Concentrations and 1 σ errors calculated for closest sample with

2 Calculated using
terrestrial water concentration, W_{sed} = 20.0 ± 5.0 wt%
enamel density, ρ_{mol} = 2.95 ± 0.02 g/cm^3
clastic sediment density, ρ_{sed} = 2.66 ± 0.01 g/cm^3

3 Data not yet available.

4 May have dentine contamination: Not included in means.

Table 3. U in the Pesturina Teeth.

Sample		U Concentration (ppm)	
		Enamel	Dentine
AT23en1		0.10	2.56
AT23en2		0.02	1.64
AT23en3		0.04	3.46[2]
AT23en4		0.07[2]	3.46[2]
AT23en5		0.07	5.39
AT23en6		0.11	4.25
Mean		0.07	3.46
	±	0.03	1.19
AT22en1		0.04	1.67
AT22en2		< 0.01[1]	1.79
AT22en3		0.01	1.29
AT22en4		0.11	1.45
AT22en5		0.07	2.32
AT22en6		0.08	1.63
AT22en7		0.05	1.61
AT22en8		< 0.01[1]	1.39
Mean		0.05	1.64
	±	0.03	0.30
AT24en1+2		0.20	1.95
	±	0.02	0.02
AT32en1		0.07	1.42
AT32en2		0.02	0.98
AT32en3		0.07	0.86
AT32en4		0.07	1.22
AT32en5		0.06	1.16
AT32en6		0.10	0.64
AT32en7		< 0.01[1]	0.81
AT32en8		0.01	0.85
Mean		0.05	1.00
	±	0.03	0.24
AT36en1		0.07	2.38
	±	0.02	0.02
Typical errors	±	0.02	0.02
Detection	~	0.01	0.01
limits[3]	-	0.02	0.02
Water conc'ns		0.02	0.05
(wt%)	±	0.02	0.02

[1] Assumed to be 0.0 ± 0.0 for calculations.
[2] Value not available: Used sample mean.
[3] Typical detection limits depend on the sample mass and tissue type.

Table 4. Sedimentary Water Analyses, Pešturina, Serbia.

Sample	Layer	Mass Initial (mg)	Mass Final (mg)	Mass Water (mg)	Water Concentration (vol%)
2012PES5b	2	5181.7	4522.5	659.2	12.7
2012PES06	2	5153.1	4780.1	373.0	7.2
2012PES07	2	5265.6	4673.5	592.1	11.2
2012PES08	2	5188.0	4682.1	505.9	9.8
2012PES09	2	5449.4	4959.4	490.0	9.0
2012PES27	2	5219.4	4365.6	853.8	16.4
2012PES51	2	5934.3	4805.0	1129.3	19.0
2012PES54	2	5364.1	5209.0	155.1	2.9
2012PES55	2	5898.3	5632.5	265.8	4.5
2012PES66	2	5525.6	4411.4	1114.2	20.2
2012PES78	2	5892.1	5568.7	323.4	5.5
2012PES10	2c	5603.9	5304.5	299.4	5.3
Mean	2				10.3
(n = 12)	±				5.8
2012PES22	3	5641.4	5231.4	410.0	7.3
2012PES24	3	5238.1	4593.8	644.3	12.3
2012PES25	3	5792.3	5411.5	380.8	6.6
2012PES26	3	5636.9	5138.3	498.6	8.9
2012PES43	3	5963.1	5391.0	572.1	9.6
2012PES44	3	5713.1	4977.7	735.4	12.9
2012PES45b	3	5195.6	4568.1	627.5	12.1
2012PES46b	3	5632.3	4841.7	790.6	14.0
2012PES53	3	5441.7	5157.1	284.6	5.2
2012PES56	3	5859.3	4671.9	1187.4	20.3
2012PES58	3	5807.5	5261.2	546.3	9.4
2012PES59	3	5343.2	4553.2	790.0	14.8
2012PES67	3	5846.5	5409.3	437.2	7.5
2012PES68	3	5018.6	4463.3	555.3	11.1
2012PES73b	3	5468.2	4881.6	586.6	10.7
2012PES74	3	5451.4	4510.1	941.3	17.3
2012PES75	3	5515.2	4688.2	827.0	15.0
2012PES77	3	5301.3	5016.1	285.2	5.4
2012PES79	3	5417.7	4657.7	760.0	14.0
2012PES80	3	5088.1	4507.9	580.2	11.4
2012PES81	3	5600.1	4976.8	623.3	11.1
2012PES82	3	5804.2	5482.7	321.5	5.5
Mean	3				11.0
(n = 22)	±				4.0
2012PES01b	4a	5259.7	4536.4	723.3	13.8
2012PES02	4a	5680.4	5219.6	460.8	8.1
2012PES03	4a	5017.7	4357.0	660.7	13.2
2012PES04	4a	5260.6	4495.5	765.1	14.5
2012PES50b	4a	5235.8	5190.3	45.5	0.9
2012PES71	4a	5219.1	4612.1	607.0	11.6
Mean	4a				10.4
(n = 6)	±				5.2

...continued

Sample	Layer	Mass Initial (mg)	Mass Final (mg)	Mass Water (mg)	Water Concentration (vol%)
2012PES12	4b	5921.7	4573.1	1348.6	22.8
2012PES14	4b	5449.2	4902.7	546.5	10.0
2012PES15	4b	5262.5	4574.4	688.1	13.1
2012PES16a	4b	5269.2	4557.1	712.1	13.5
2012PES16b	4b	5196.2	4946.0	250.2	4.8
2012PES17	4b	5706.9	4848.8	858.1	15.0
2012PES18	4b	5251.7	4304.4	947.3	18.0
2012PES19	4b	5002.9	4624.3	378.6	7.6
2012PES20	4b	5986.2	5619.6	366.6	6.1
2012PES21	4b	5668.5	5453.8	214.7	3.8
2012PES28b	4b	5083.6	4227.5	856.1	16.8
2012PES29	4b	5600.6	4508.2	1092.4	19.5
2012PES31	4b	5157.9	4395.8	762.1	14.9
2012PES33	4b	5019.8	4831.4	188.4	3.8
2012PES36	4b	5327.2	4655.4	671.8	12.6
2012PES37	4b	5150.9	4707.1	443.8	8.6
2012PES40	4b	5272.5	4016.4	1256.1	23.8
2012PES41	4b	5047.1	4522.0	525.1	10.4
2012PES42	4b	5170.5	4402.7	767.8	14.9
2012PES47b	4b	5218.8	4872.0	346.8	6.7
2012PES48b	4b	5216.4	4409.2	807.2	15.5
2012PES61a	4b	5194.3	4348.5	845.8	16.3
2012PES62	4b	5594.8	4645.7	949.1	17.0
2012PES63	4b	5199.5	4170.5	1029.0	19.8
2012PES64	4b	5527.7	4615.8	911.9	16.5
2012PES65	4b	5293.4	4305.3	988.1	18.7
2012PES69	4b	6573.7	4833.7	1740.0	26.5
2012PES70	4b	5904.1	4841.8	1062.3	18.0
2012PES72	4b	5070.4	4682.1	388.3	7.7
mean	4b				13.9
(*n* = 29)	±				6.1

Table 5. Preliminary ESR ages for Pešturina, Serbia.

Sample		Accumulated Dose, $\mathscr{A}_{\Sigma}$[1] (Gray)	$\overline{D}_{sed}(t)$[1] (μGy/y)	ESR Ages[1,2] EU (ka)	LU (ka)	RU (ka)
a. AT23, 2012PES46a, *Capra ibex* molar, Layer 3						
AT23en1		21.60	520.5	32.8	36.8	40.6
	±	0.73	89.9	4.6	5.8	7.0
AT23en2		27.47	520.5	43.7	48.0	51.8
	±	0.80	89.9	6.4	7.6	8.9
AT23en3		20.02	520.5	30.6	34.2	37.6
	±	0.59	89.9	4.3	5.4	6.5
AT23en4		19.35	520.5	28.3	32.3	36.2
	±	0.78	89.9	3.9	5.0	6.3
AT23en5		23.00	520.5	32.3	37.5	42.8
	±	0.57	89.9	4.2	5.6	7.3
AT23en6		27.02	520.5	38.9	44.8	50.6
	±	1.11	89.9	5.3	6.9	8.8
Mean		23.12		34.3	38.9	43.3
(*n* = 6)	±	0.30		1.9	2.5	3.1
Mean		22.07		32.6	37.2	41.5
(- AT23en2)	±	0.32		1.8	2.3	2.9
b. AT22, 2012PES50a, *Equus* cheek tooth, Layer 4a						
AT22en1		39.99	479.4	72.2	77.8	82.3
	±	1.50	77.8	10.5	12.2	13.6
AT22en2		47.46	479.4	85.8	92.3	97.7
	±	2.63	77.8	13.0	15.0	16.6
AT22en3		58.54	479.4	107.5	114.9	120.7
	±	2.74	77.8	16.2	18.4	20.5
AT22en4		44.52	479.4	78.2	85.5	91.4
	±	2.38	77.8	11.5	13.6	15.7
AT22en5		43.07	479.4	77.3	83.6	88.8
	±	1.25	77.8	11.1	12.9	14.7
AT22en6		45.15	479.4	80.9	87.6	92.8
	±	2.24	77.8	12.0	14.0	15.6
AT22en7		55.85	479.4	104.7	113.3	115.0
	±	2.95	77.8	15.0	17.4	19.4
AT22en8		44.66	479.4	82.4	87.9	92.1
	±	2.10	77.8	12.5	14.1	15.4
Mean		46.12		86.1	92.9	97.5
(*n* = 8)	±	0.71		4.5	5.2	5.8
Mean		47.35		88.1	95.1	99.7
(- AT22en1)	±	0.56		2.9	3.2	3.5
Mean		44.62		83.2	89.9	94.2
(- AT22en3)	±	0.72		4.6	5.4	6.0

... continued

Sample		Accumulated Dose, $\mathcal{A}_{\Sigma}$[1] (Gray)	$\overline{D}_{sed}(t)$[1] (μGy/y)	ESR Ages[1,2] EU (ka)	LU (ka)	RU (ka)
c. AT24, 2012PES28a, *Equus* milk molar, Layer 4b						
AT24en1+2		50.44	413.6	88.1	103.5	118.0
	±	2.82	64.1	11.1	14.8	19.0
d. AT32, 2012PES51a, *Equus* cheek tooth, Layer 4b						
AT32en1		44.17	432.3	87.0	94.6	100.6
	±	1.96	67.6	12.3	14.4	16.2
AT32en2		52.46	432.3	108.2	115.0	120.0
	±	2.19	67.6	16.8	17.8	19.3
AT32en3		42.29	432.3	85.8	91.9	96.6
	±	1.43	67.6	12.2	13.9	15.4
AT32en4		43.77	432.3	87.6	94.5	99.9
	±	1.61	67.6	12.4	14.3	15.9
AT32en5		41.96	432.3	85.3	91.3	95.9
	±	1.31	67.6	12.1	13.8	15.2
AT32en6		55.27	432.3	110.8	119.6	126.2
	±	1.93	67.6	15.6	18.1	20.1
AT32en7		41.01	432.3	86.7	90.9	94.1
	±	1.67	67.6	13.0	14.2	15.2
AT32en8		53.31	432.3	112.0	117.9	122.3
	±	1.60	67.6	16.4	18.1	19.4
mean		47.03		95.2	101.9	107.0
(n = 8)	±	0.73		3.5	3.8	4.2
mean		45.79		92.8	99.4	104.2
(- AT32en6)	±	0.62		5.1	5.7	6.3
e. AT36, 2012PES48a, rhinoceros cheek tooth, Layer 4b						
AT36en1		21.86	265.6	55.5	67.0	78.9
	±	1.14	43.1	6.8	9.5	12.9
Layer 4b mean				94.2	102.1	108.2
(n = 9)[3]	±			4.5	5.2	5.8

[1] All errors are 1 σ.
Abbreviations:

$\overline{D}_{sed}(t)$[1]	=	volumetrically averaged sedimentary dose rate
EU	=	assuming early U uptake, p = -1
LU	=	assuming linear U uptake, p = 0
RU	=	assuming recent U uptake, p = 10

[2] Ages calculated using

α/γ factor, κ_{α}	=	0.10	±	0.01	
initial U activity ratio, $({}^{234}U/{}^{238}U)_0$	=	1.2	±	0.20	
aragonite density, ρ_{mol}	=	2.95	±	0.01	g/cm^3
radon loss from the shells, Rn_{mol}	=	0.0	±	0.0	vol%
carbonate sediment density, ρ_{cal}	=	2.96	±	0.01	g/cm^3
quartz sediment density, ρ_{qtz}	=	2.66	±	0.01	g/cm^3
sedimentary water concentration, $\overline{W}_{sed}$	=	20.0	±	10.0	wt%

Uses $\overline{D}_{sed}(t)$ and $\overline{D}_{cos}(t)$.

[3] Omitting AT36, which clearly has been reworked.

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RADIOCARBON CHRONOLOGY OF PEŠTURINA CAVE

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Abstract: Here we present the results and implications of AMS radiocarbon dates from Pešturina Cave. Dated faunal samples demonstrate considerable mixing within Pleistocene layers. Spatially associated materials cannot be assumed to be contemporaneous. Dated bones with signs of human modification provide direct evidence for human activity at least around 16 kcalBP, 30 kcalBP, and 45 kcalBP. Comparing these dates to the lithic industries identified at Pešturina, it most likely that the 30 kcalBP date represents a Gravettian or Early Epigravettian phase, while the 45 kcalBP date marks a Late Mousterian occupation.

Key words: Pešturina, radiocarbon dating, Paleolithic, Serbia

Introduction

Pešturina is a medium-sized karstic cave in southeast Serbia, which contains remains left by Paleolithic humans as well as carnivores. Located near the Nišava river, Pešturina has been excavated in six seasons between 2006- 2014. The campaigns have removed over 20 m^2 of sediment, which revealed four geological layers with differing archaeological and paleontological characters. Here we present the radiocarbon dating program and results for Pešturina, and discuss the implications of these results for understanding the site's stratigraphy and human occupations.

Geologic and archaeological stratigraphy

Excavation methodology and lithics analysis are described in detail elsewhere (Mihailović and Milošević 2012; Mihailović this volume). The excavated sequence comprises four geologic layers, which vary in thickness and integrity across the cave (Fig. 1). Some areas show marked erosional horizons and bioturbation. The uppermost geologic layer 1 consists of ~25-50 cm of loose humic silts, assumed to be Holocene

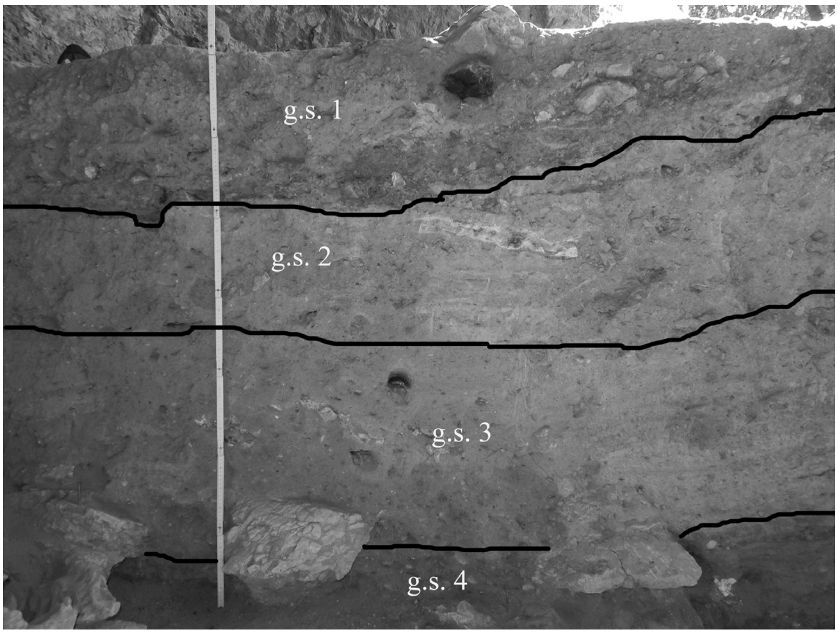

Figure 1. Southern section of squares O11 and O12 showing four geological layers. The uppermost layer 1 contains Holocene deposits, while layers 2-4 are of Pleistocene age.

deposits. The underlying Pleistocene layers consist of more compact fine silt with minor clay and occasional limestone stones. Within the Pleistocene layers are artifacts of Upper and Middle Paleolithic character, as well as faunal remains deposited by humans and carnivores.

Geologic layer 2 comprises 50-70 cm of the Pleistocene sediment described above, in addition to localized lenses with more loose, friable silt or cemented calcite. About 100 chipped stone artifacts of mostly flint and high quality chalcedony have been recovered from layer 2. Nearly 30% are tools, predominately backed pieces, retouched blades and flakes, and truncated pieces. Based on typo-technological features, this assemblage resembles Gravettian or Early Epigravettian industries found in the Balkans Upper Paleolithic.

Geologic layers 3 and 4 are difficult to distinguish by sedimentology and in-field observation. Both comprise brown fine-grained silt, but geologic layer 4 is characterized by looser silt with more inclusions of fine to medium gravel. Both layers contain Middle Paleolithic flake-based industries made from local quartzite. The layer 3 assemblage has been described as Denticulated Mousterian, and the most common tools are notches and denticulates. In layer 4 tools include natural backed knives and sidescrapers with Quina or demi-Quina retouch. The layer 4 assemblage has been classified as Charentian with Quina elements.

Chronological questions

Given the above geological and archaeological stratigraphy, the radiocarbon dating program was designed to answer the following questions. 1) How disturbed is the stratigraphy; can spatially associated remains be assumed to be contemporaneous? 2) When did humans occupy the cave, and can we assign temporal phases to the apparent technocomplexes? 3) How do the dates of human occupations at Pešturina Cave fit into the regional chronology?

Methods

Sample selection

It was evident from the beginning of excavations that Pešturina Cave would present a challenging context for absolute dating of archaeological units. During excavation features were observed that could obscure the chronostratigraphy, including erosional horizons and rodent burrows. The sequence is shallow and disturbed. No combustion features were found within Pleistocene layers. Faunal remains were the only suitable material for radiocarbon dating, but were brought to the cave by both humans and carnivores.

Consequently, specimens were chosen for radiocarbon dating by the following sampling strategy. Medium or large mammal long bones were selected from excavated areas that appeared to have the least disturbed stratigraphy; areas of obvious bioturbation or ambiguous layer boundaries were avoided. In order to better characterize the sedimentary sequence, as it relates to the context of radiocarbon dates, sequences of loose sediment and micromorphological blocks were taken from multiple sections. The loose sediments were measured by Fourier Transform Infrared (FTIR) Spectrometry, which provided qualitative mineral composition.

Of the bones from the best contexts, preference was given to specimens with signs of human modification such as cut marks and percussion marks. These taphonomic features were identified by zooarchaeologist S. Milošević using binocular light or scanning electron microscopy, depending on the clarity of the feature. Moreover, in order to maintain an archive of probable cutmarks for reassessment, molds were taken of the marks with vinyl polysiloxane dental mold (Pearson Dental 3M Poly Vinyl Express Garant). The molds produce accurate copies of the bone surface features, which can be imaged and analyzed by the same methods as the actual feature (Bello et al. 2011). Unfortunately signs of human modification were rare or difficult to identify, due to natural surface weathering of bones and carnivore activity. Therefore some bones without apparent human modifications were included in the dating program.

Prescreening

The remaining sample (n=29) was culled based on preservation parameters measured in the D-REAMS radiocarbon laboratory, Weizmann Institute – Max Planck Center for Integrative Archaeology (Yizhaq et al. 2005). First, bones were crushed into powder and dissolved in 1 N HCl. The percent insoluble fraction was calculated as the weight of the remaining fraction after acid dissolution divided by the weight of bone powder before dissolution. The insoluble fraction contains the organic portion of bone—predominantly the protein collagen—as well as any insoluble contaminants, such as clay. Fresh, modern bone has an organic content of ~20% and most laboratories will only date bones with >1% insoluble fraction (Van Klinken 1999). In the D-REAMS laboratory, the insoluble fractions are further characterized by FTIR spectrometry in order to ensure that the fractions are well-preserved collagen, rather than contaminant insoluble material or severely degraded collagen. Therefore, we do not automatically use >1% insoluble fraction as a threshold for dating, but rather *will* date samples with less than 1% insoluble fraction that appear to be pure collagen and will *not* date samples with greater than 1% insoluble fraction that do not reflect collagen.

FTIR spectrometry was also performed on untreated bone powder. These spectra were used to calculate the splitting factors (SF), a measure of the crystallinity of carbonate apatite crystals, which increases with diagenetic reprecipitation of bone (Weiner and Bar-Yosef 1990). Splitting factors of modern bone range between 2.5-2.9 (Ziv and Weiner 1994); those of fossil bone usually fall between 3-4, but can be as high as 7 (Berna et al. 2003). SF is calculated from the FTIR spectra of bone powder as the sum of the peak heights at 565 cm^{-1} and 604 cm^{-1} divided by the valley height between them, measured from a standardized baseline (Fig. 2).

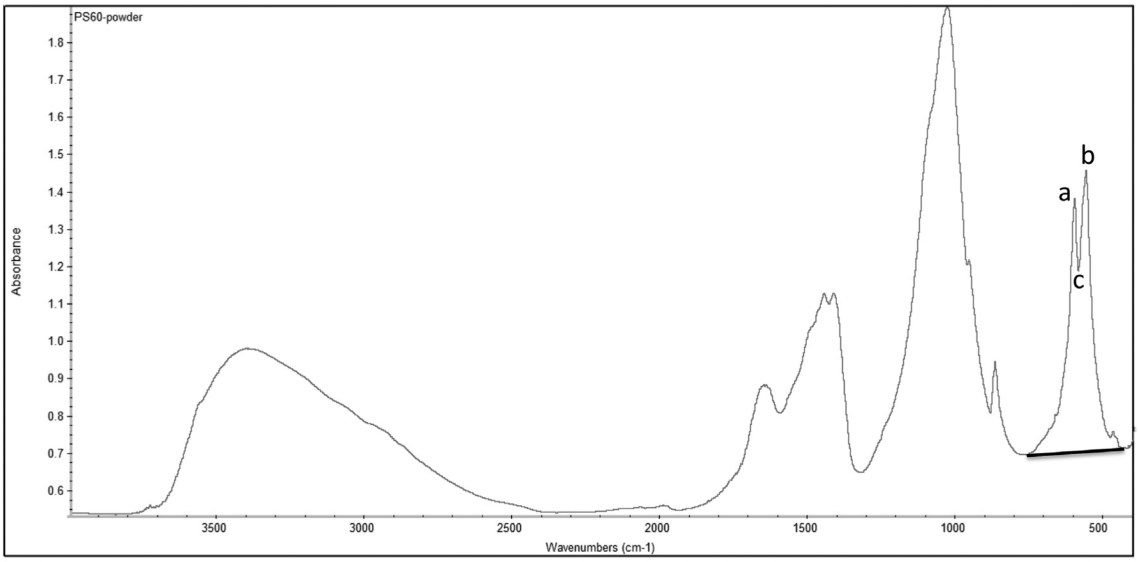

Figure 2. FTIR spectrum of bone powder showing characteristic peaks for carbonated hydroxylapatite mineral. Splitting factor (SF) is calculated as (a+b)/c, where a and b are the height of FTIR absorption peaks at 604 and 565 cm-1, respectively, and c is the height of the valley between them. Heights are measured from a baseline extending from the base of the valley before 565 cm-1 to the lowest point after 874 cm-1 (Weiner and Bar-Yosef 1990).

FTIR samples of insoluble fraction, bone powder, and sediment were measured by crushing and homogenizing a few milligrams of sample with an agate mortar and pestle. Approximately 0.1-0.3 mg of sample was then mixed with ~50 mg KBr powder and pressed into a 7-mm pellet with a manual hydraulic press. Spectra were measured with a Nicolet 380 (Thermo) at 4 cm^{-1} resolution for 32 scans between 4000-250 cm^{-1}.

Pretreatment and Accelerator Mass Spectrometry

Ten bones passed our selection criteria for context and preservation. These samples were prepared for AMS by modified methods of collagen purification with ultrafiltration described by Brock et al. (2010) and Yizhaq et al. (2005). Bone samples were mechanically cleaned of sediment with a scalpel and crushed into powder with an agate mortar and pestle. Between 0.5- 1 g of bone powder was subjected to the following acid-base-acid (ABA) treatment: 0.5 N HCl until bone mineral was dissolved (~1 hour, when reaction ceased), followed by washing in Nanopure water until pH neutral; 0.1 N NaOH solution for 30 minutes, followed by washing in Nanopure until pH neutral; 0.5 N HCl for five minutes, followed by washing in Nanopure until pH = 3. The solutions were gelatinized at 70°C in a vacuum oven for 20 hours, and then passed through Eezi-filters™ and ultrafilters (Vivaspin™15, 30kD MWCO), which had been cleaned by established procedures (Brock et al. 2007). Gelatinized, purified collagen was freeze-dried for 24 hours. Samples were placed in sealed quartz tubes with ~200 mg CuO and combusted at 900°C to CO_2 and then reduced to graphite in a vacuum line. Two samples did not survive the pretreatment procedure.

Five samples (those with RTK sample IDs) were sent to the NSF-AMS Radiocarbon Laboratory in Tucson, Arizona for final measurement. Three samples (those with RTD sample IDs) were measured at the D-REAMS radiocarbon laboratory. Radiocarbon years were converted into calendar years using the IntCal13 atmospheric curve (Reimer et al. 2013) and OxCal software v 4.2.3 (Bronk Ramsey 2009).

Results and discussion

Bone preservation and sedimentology

The insoluble fraction ranged from 0- 3.5% with an average value of 1.1%. Splitting factors ranged from 2.7-3.5 with an average value of 3.0 (Fig. 3, Table 1). The quality of FTIR of insoluble fractions varied, and only those with representative collagen peaks were selected for dating. Insoluble fraction spectra of some dated and rejected samples are shown in Figure 4. Mineralogically, sediment throughout the Pleistocene layers is fairly uniform, consisting of apatite-rich clay; no strong and consistent differences in sediment mineral composition were observed that distinguish layers 2-4. Full descriptions of the sediment mineralogy and micromorphology will be presented elsewhere (Alex in prep).

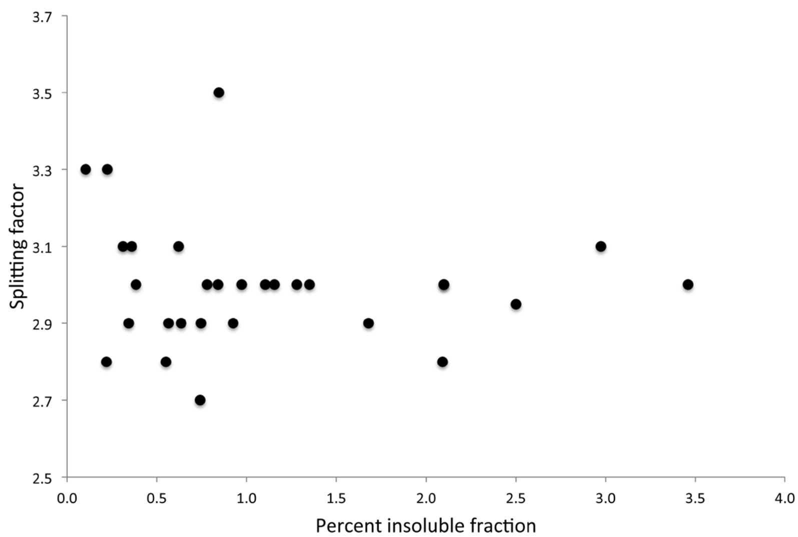

Figure 3. Points represent prescreened bone samples plotted by their splitting factor and percent insoluble fraction. Splitting factor for modern bone ranges between 2.5-2.9, and increases with diagenetic reprecipitation. Percent insoluble fraction represents the percent of bone that survives acid dissolution in 1 N HCl and >1% is often used as a cutoff for radiocarbon dating.

field ID	% insoluble fraction	splitting factor
PS21	0.7	2.7
PS22	0.2	2.8
PS23	1.1	3
PS25	1.0	3
PS27	0.6	2.9
PS29	0.3	2.9
PS30	0.3	3.1
PS32	0.6	2.8
PS33	3.0	3.1
PS34	0.6	2.9
PS35	0.9	2.9
PS36	0.2	3.3
PS37	0.7	2.9
PS38	0.4	3
PS39	0.1	3.3
PS40	1.2	3
PS41	1.3	3
PS42	2.1	2.8
PS43	1.7	2.9
PS44	0.8	3.5
PS45	2.5	2.95
PS50	2.1	3
PS51	1.4	3
PS52	2.1	3
PS56	0.6	3.1
PS57	0.8	3
PS60	3.5	3
PS64	0.4	3.1
PS72	0.8	3

Table 1. Values of preservation parameters for samples prescreened for radiocarbon dating. Parameters explained in text and Figure 3.

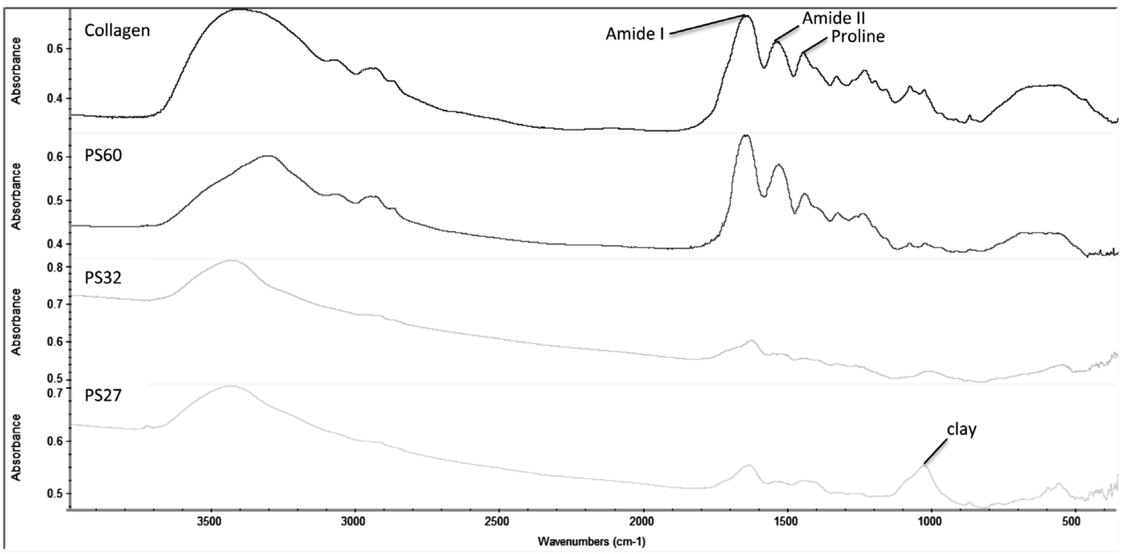

Figure 4. FTIR spectra of pure, fresh collagen (top) compared to the insoluble fractions of bones from Pešturina. From top: pure collagen showing distinctive profile of absorption peaks for amide I (1655 cm-1), amide II (1540 cm-1), and the amino acid proline (1455 cm-1); sample PS60 (RTD7231) appears to be pure collagen; sample PS32 appears to have degraded collagen and was not dated; sample PS27 shows contaminant clay peak (1036 cm-1) in addition to weak collagen peaks. This sample also was not dated.

Radiocarbon measurements

Radiocarbon measurements are presented in Table 2 and Figures 5 and 6. Samples attributed to geologic layer 2 range from 13,442 ± 58 ^{14}C BP to >37,800 ^{14}C BP; samples attributed to geologic layer 3 range from 28,682 ± 176 ^{14}C BP to 40,229 ± 3597 ^{14}C BP; and the one sample attributed to geologic layer 4 (RTD7149) dates to 40,497 ± 591 ^{14}C BP. Two of the dates (RTK6449 and RTK6450) may extend beyond the range of the calibration curve. The radiocarbon dates from layer 3 overlap with the ESR date of 39 ± 3 ka for this layer, while the radiocarbon date from layer 4 is substantially younger than the corresponding ESR dates of 93 ± 5 ka and 102 ± 5 ka (Blackwell, this volume).

lab ID	field ID	geologic layer	excavation layer	square	taxa	element	taphonomy	14C BP	+/-	calBP (68%)		% eff.	%C	d13C	C/N
RTD7148	PS50	2	4	L9b	MM	radius or ulna	cutmarks	13442	58	16271	16077	1			
RTK6446	PS25	2	4	M9b	cervid	tibia	percussion	26121	622	30888	29691	1.4	42.6	-19.2	2.8
RTK6445	PS23	2	9	N11c	cervid	femur or tibia		>37800				2.4	38	-19.1	2.8
RTD7231	PS60	3	12	M7b			bone flake	28682	176	33129	32496	0.7	36		
RTK6449	PS33	3	15	O11b	equid	femur	possible scraping, hyena gnawing	40229	3597	47608	41932	1.8	42.9	-20.6	2.8
RTK6447	PS30	3/4	10	M10a	equid	humerus	possible cutmarks	>41100				1.2	41.3	-18.4	2.7
RTK6450	PS35	3/4	21	N10b				36174	2171	42921	38526	1.4	40.2	-20.2	2.7
RTD7149	PS52	4	22	N9b	equid	femur	cutmarks	40497	591	44599	43502	1	33		

Table 2. Sample information and radiocarbon measurements for dated material.

The geological layers identified during excavation contain faunal remains from broad and overlapping timespans, and the absolute dates of the remains are not consistent with their stratigraphic position. Even from this limited number of absolute dates, it is clear that materials found in close spatial proximity may differ greatly in age. This point is particularly evident when comparing samples RTD7148 (13,442 ± 58 ^{14}C BP) and RTK6446 (26,121 ± 622 ^{14}C BP). The two bones, both with human modifications, came from the same excavation layer in adjacent squares in the area of the cave thought to have the best preserved and clearest stratigraphy, based on field observations. However, the samples differ in absolute age by over 10,000 years. This result has critical implications for the defining of archaeological units: artifacts cannot be assumed to be contemporaneous or produced by the same population based on their provenience or spatial association upon excavation. Archaeological units for Pešturina Cave should be defined primarily by typo-technological differences in artifacts, rather than geologic-stratigraphic units.

While all dated bones were used to evaluate the stratigraphic integrity of Pešturina Cave, only the bones with human modifications are direct evidence for human activity in the cave. Considering these specimens shows that

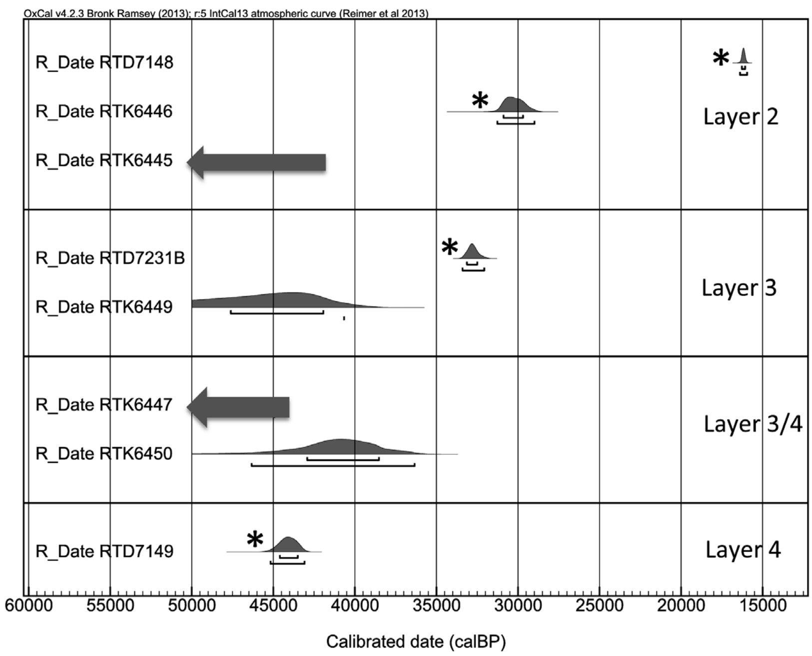

Figure 5. Highest probability density functions of calibrated radiocarbon dates, using the IntCal13 atmospheric curve (Reimer et al. 2013) and OxCal software v 4.2.3 (Bronk Ramsey 2009). Arrows represent samples that produced infinite dates. Stars indicate samples with signs of human modification.

humans were present *at least* between 16,300-16,100 calBP, between 33,100- 29,700 calBP, and between 44,600-43,500 calBP (68% highest probability density). Comparing these minimal estimates for occupational phases to the typo-technological classifications at Pešturina leads to the following hypotheses: The artifacts, mainly from layer 2, described as Gravettian or Early Epigravettian were most likely created by the population present between 33,100- 29,700 calBP. Middle Paleolithic artifacts were left by humans present between 44,600- 43,500 calBP, who may have created the assemblages described as Charentian, Denticulate Mousterian, or both.

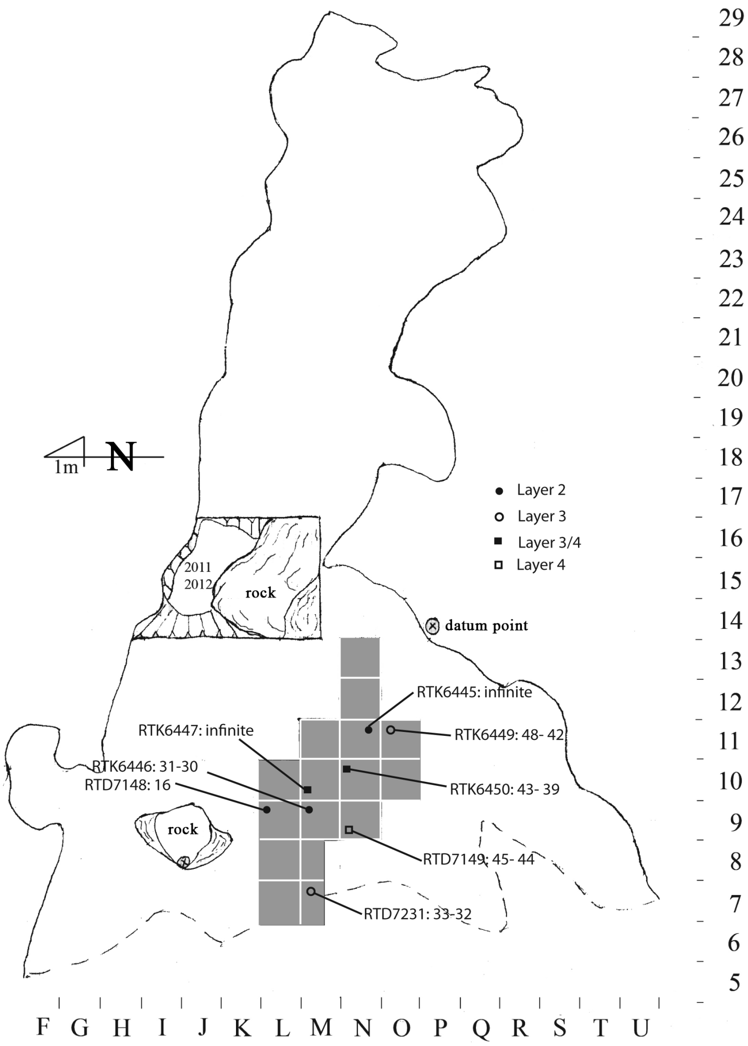

Figure 6. Locations of measured radiocarbon samples on Pešturina plan. Color of points indicates the geologic layer of samples. Dates are calBP. Top plan reflects area excavated as of 2013, when the last radiocarbon samples were taken.

These phases are consistent with the emerging regional chronology, which is based on a small number of well-stratified and dated sites. At nearby sites to the west of Pešturina, Mousterian assemblages persist until around 40 ka. The final Mousterian layer (XII) at Crvena Stijena, Montenegro is dated to 45- 44 kcalBP (GrN-6083: 40,770 ± 900 ^{14}C BP) and directly underlies CI eruption tephra dated to 39,280 ± 110 years ago by ^{40}Ar/^{39}Ar (De Vivo et al. 2001; Morley and Woodward 2011). The penultimate Mousterian layer (XIII) has not been dated, but is classified as Denticulate Mousterian and resembles the layer 3 assemblage at Pešturina. At Smolućka Cave, Serbia, a charcoal associated with Mousterian artifacts produced an infinite age of 38,000 ^{14}C BP (OxA-1251) (Hedges et al. 1990).

Initial Upper Paleolithic (IUP) sites appear to the east of Pešturina along the Danube corridor between 45-40 kcalBP, at the Bulgarian sites of Temnata (Ginter et al. 1996) and Bacho Kiro (Hedges et al. 1994). At the same time, Uluzzian sites appear to the southwest, along the coasts of Greece and Italy (Douka et al. 2014). Both of these industries are thought to represent modern human migrations into Europe. Although they overlap temporally with the 45 kcalBP human occupation at Pešturina, no evidence for blade-based IUP traditions has been found at Pešturina. Therefore, it is most likely that at 45 kcalBP Pešturina was occupied by Neanderthals continuing local Mousterian traditions.

The layer 2 assemblage from Pešturina appears similar to Gravettian or Early Epigravettian assemblages found at the Bosnian site of Kadar, Serbian sites of Šalitrena and Hadži Prodanova, and Bulgarian sites of Temnata and Kozarnika (Mihailović and Milošević 2012). The Gravettian layers at Temnata cave have been dated to 35-25 kcalBP (Ginter et al. 1996), which overlaps temporally with the 33-30 kcalBP occupation at Pešturina.

Conclusion

Pešturina Cave contains artifacts from distinct archaeological traditions of the Middle and Upper Paleolithic. Establishing chronology at Pešturina Cave is complicated by the disturbed, palimpsest nature of the deposits. Radiocarbon dates of faunal remains that were found in close spatial proximity vary substantially in age. Therefore it cannot be assumed that spatially associated materials were contemporaneous, and archaeological units should be based on techno-typological differences. Based on bones with human modifications, there is evidence for human occupations at least between 16,300- 16,100 calBP, between 33,100- 29,700 calBP, and between 44,600- 43,500 calBP. Considering these dates in conjuncture with the lithics at Pešturina and regional culture-history, it is most likely that around 30 kcalBP Pešturina was occupied by modern humans producing Gravettian or Early Epigravettian industries; around 45 kcalBP the cave was most likely used by late Middle Paleolithic Neanderthals.

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THE PROSPECTS FOR UTILIZING PEDOLOGY, GEOLOGY AND OTHER LANDSCAPE DATA FOR LOCATING OPEN-AIR PALEOLITHIC SITES IN SERBIA

Eric Heffter

Abstract: Due to its karst landscape and the general difficulty of finding open-air sites, Paleolithic archaeology in Serbia has largely focused on locating and excavating caves. While caves provide valuable archaeological data, open-air sites need to be discovered and excavated to better understand hominin land use during the Middle and Upper Paleolithic. While open-air sites (especially subsurface ones) are difficult to locate during survey, their discovery can be aided by utilizing various kinds of landscape data. This paper explains how pedological and geological data, as well as local knowledge can aid in creating GIS models which may predict locations of open-air archaeological sites.

Key words: Paleolithic, Serbia, open-air sites, pedology, geology, GIS

Introduction

Paleolithic archaeology in Serbia received comparatively little attention from researchers until the 1990s when excavations of sites began in earnest (Darlas and Mihailović 2008). While Middle and Upper Paleolithic sites have been discovered and are being excavated, they are still modest in number. Most Paleolithic sites so far discovered date to the Epi-Gravettian (18-15 ka), Gravettian (28-18 ka) and Middle Paleolithic (>45ka). Early Upper Paleolithic sites, which would provide evidence for the first appearance of modern *Homo sapiens* in the region, are scarce (Kuhn et al. this volume). This stands in marked contrast to neighboring areas such as Bulgaria, Romania and the Western Ukraine which contain some of the earliest Upper Paleolithic sites in Europe (Schmidt et al. 2013). The scarcity of Early Upper Paleolithic sites may indicate that the area was sparsely occupied by humans during this time, or, alternatively, that these sites have simply not been discovered (Kuhn et al. this volume).

The near-exclusive focus on excavating caves further complicates our understanding of the apparent scarcity of Early Upper Paleolithic sites in Serbia, as it is possible that sites dating to this period may be located in open-air contexts. While our understanding of human settlement patterns would be greatly increased by locating and excavating open-air sites, they are notoriously difficult to identify. By using multiple sources of data to create GIS models we may be able to develop a framework for understanding where open-air sites are most likely to occur. This paper explains how data derived from pedology, geology, toponyms and local knowledge can be useful in constructing GIS models to locate open-air sites, raw material sources and artifact surface scatters.

Soil Data

Data on soils provide valuable information about the local landscape including (but not limited to) its stability over time as well as its age (Walkington 2010). For example, degree of soil development can inform us about how the landscape has changed over time. A soil that is well developed (with a topsoil, and thick subsoil) indicates that the landscape has been stable for many years with minimal sediment input (Holliday 1990). This is in contrast to more active landscapes such as alluvial plains where sediment from rivers can be continually deposited. Active sedimentary regimes may either bury existing soils (forming paleosols) or prevent long term soil development due to new sediment input (Ferring 1992). While open-air deposits are best found in stratified subsurface layers, it is extremely difficult to find these layers during a surface survey unless part of the landscape has been eroded or cut by rivers (Ferring 2001).

However, where can archaeologists find information about soils? One place is in soil surveys, which until recently were vastly underutilized by the archaeological community (Holliday 1990). While not designed with archaeologists in mind, these soil surveys provide information on the kinds of soils found in an area, and contain additional information on soil horizon depth, sediment particle size and other data of value to the archaeologist (Holliday 1990). If used properly these data can help infer potential site locations and identify areas on the landscape where soils are old enough to contain archaeological sites of interest to the researcher. Researchers can use also soil taxonomic orders as a rough indicator of soil age (Table 1) (Yassoglou and Haidouti 1978).

Soil survey maps exist for Serbia but several issues complicate their use for the purpose of prospecting for Pleistocene sites, including the use of non-standard (and sometimes contradictory) nomenclature for soil classes, lack of a systemic color characterization scheme, incomplete soil profile documentation and spatial data which locates soil pits relative to the nearest village (Protic et al. 2005). Non-standard terminology complicates the interpretation of soils recorded in surveys in Serbia, especially for researchers who are from outside the country and are unfamiliar with this local soil taxonomy. However, it is possible to 'translate' the Serbian soil orders into taxonomies more familiar to researchers, such as the USDA Soil Taxonomy and the World Reference Base for Soil Resources Taxonomy (Table 1).

Soil Group	Equivalent USDA Taxonomy Group (Soil Survey Staff 2010)	FAO/WRB (IUSS 2006)	Minimum age (years)	Source
Chernozems	Mollisol	Chernozem	1,000-2,000	Birkeland 1984
Brown Soils	Alfisols	Luvisols	>10,000	Birkeland 1984
Smonitsas	Vertisols	Vertisols	1,000	Mckeague et al. 1978
Meadow Soils	Entisols, Inceptisols, Mollisols	Gleysols	100-1,000	Mckeague et al. 1978
Marshy Soils	Mollisols	Gleysols	Several thousand	Birkeland 1984
Podzolic Soils	Spodosols	Podzol	Several thousand, potentially up to 10,000	Mckeague et al. 1978; Stevens and Walker 1970 and references therein.
Alluvial Deposits	Entisols	Fluvisols	Variable, less than 1,000	Birkeland 1984
Deluvial Soils	Entisols (?)	Fluvisols	Variable, less than 1,000	Birkeland 1984
Sandy Soils	Unknown	Unknown	Unknown	-
Brown Forest Skeletoid Soils	Alfisols	Luvisols	>10,000	Birkeland 1984

Table 1. Soil Orders and Ages

The period in which the soil surveys were done also affects their utility for archaeological applications. The most comprehensive soil surveys occurred during the 1960s for areas including the Morava and Mlava river basins: these have been mapped at a scale of 1:50,000 (Protic et al. 2005). The soil surveys emphasized properties associated with agricultural use (Pešić 1967: 223-244). Unfortunately by the 1980s and 1990s soil surveys in Serbia ceased, leaving soil mapping incomplete (Protic et al. 2005). While there have been proposals to map soils in Serbia at 1:25,000 scale, this has not been accomplished (Protic et al. 2005). Therefore, data derived from Serbian soil survey data will be very general, with limited spatial resolution. Nonetheless, these surveys still provide valuable information about areas on the landscape where soils are old enough to contain Paleolithic sites.

Geological and Geomorphological Data

Another type of data useful for locating open-air sites is maps displaying geological and geomorphological information. Understanding the geology of a region is important as it aids in locating raw material sources used to produce stone tools. It is also essential to understand the geomorphology of a landscape to recognize which features have the highest probability of containing open-air sites. In the context of alluvial systems, surveys and analysis should focus on alluvial terraces as opposed to other components of an alluvial system. The most obvious reason for selecting alluvial terraces involves potential site visibility, as terraces generally have much less sediment accumulation than floodplains (Ferring 1992). Even if a floodplain is no longer undergoing an active period of alluviation it is probable that potential archaeological sites (especially of Pleistocene age) have been deeply buried by previous sediment accumulation episodes (Ferring 1992).

Finally, geomorphological data can be used in concert with information from soil surveys to understand how various properties soil properties are affected by differences in parent material (King 1983). The type of parent material greatly affects the development and identification of soils, as soil properties "are strongly controlled by the physical, chemical and mineralogical characteristics of the parent materials" (King 1983:102). For example, certain parts of southeastern Serbia have very red soils. Without knowing the geology of the area, one might conclude that these soils are extremely old (redder soils are typically older as iron in the soil oxidizes over time) (Birkeland 1984). However, the use of geological maps and a cursory look at the landscape confirmed that these bright red soils derived their color from a red sandstone parent material and not because of their age.

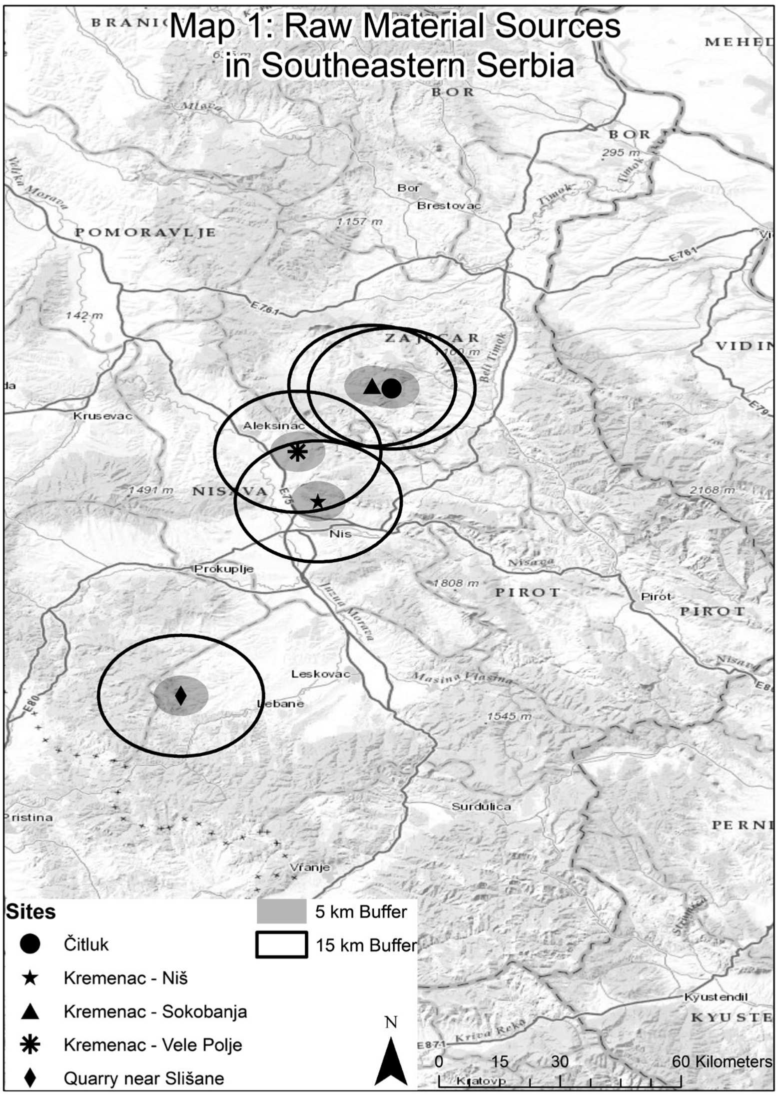
Raw Material Localities

Raw material outcrops or quarry sites can yield useful data including diagnostic artifacts or debitage, despite sometimes lacking stratigraphy and having artifacts from multiple time periods mixed together (Purdy 1984). Anecdotal experience with quarries and artifact scatters in Serbia suggests that these locations are useful for finding chronologically diagnostic pieces. At a quarry near the village of Slišane (Map 1), we identified a locality of high quality flint that contained thousands of artifacts. While the majority of these artifacts consisted of debitage, we were able to find chronologically diagnostic pieces such as Levallois flakes. While Levallois technology is prevalent throughout most of the Middle Paleolithic and thus can only serve as a very rough temporal marker, its presence confirms that hominins occupied the area during this period and extensively utilized the quarry.

One other important issue involving raw material sources is whether they can be used to predict archaeological site locations. In general, hominins during the middle Paleolithic relied heavily on local raw materials (those within 5-15 kilometers of a site), although raw materials were regularly transported more than 30 km away from their source in parts of western and central Europe (Geneste 1988, Féblot-Augustins 1993). While raw material transport distances exceeded 100 km in parts of eastern Europe during the Upper Paleolithic, the majority of raw material still came from local sources less than 15 km away (Féblot-Augustins 1997).

In southeastern Serbia there seems to be an abundance of local flint sources. During the summer of 2014, a few colleagues and I documented some previously known raw material locations (see Map 1). Subsequent analysis determined that these raw material sources generally overlapped with each other at the 15 km range, indicating that there is a high proportion of raw material on the landscape.

While hypotheses about the kinds of raw materials (local or exotic) may be tested through raw material sourcing data, the amount and type of stone tool reduction sequences may also tell us about how often local raw material sources were exploited. It is widely observed that the cost of collecting raw materials influences how carefully people conserved them (Andrefsky 1994). Where raw materials are plentiful people can afford to engage in apparently "wasteful" behaviors, thus discarding lots of potentially usable material (Andrefsky 1994). Hominins also regularly staged artifacts production across the landscape, producing artifacts near its source and carrying away only finished tools or preforms. This strategy serves to reduce the amount of low-utility material (waste) that must be transported (Kuhn 2004). What this means is that sites closer to raw material sources are likely to contain larger quantities of debris from artifact production and thus may be more visible and easier to identify (Kuhn 2004).



Map 1. Raw material sources found during 2014 survey. Note: The area between Slišane and Niš was not surveyed for raw material sources.

Local Knowledge and Toponyms

One other resource which may aid in finding archaeological sites and raw material sources is the knowledge that local people have of the landscape. While villagers and farmers may not know the names of artifacts or their importance for understanding the past, they do have an intimate knowledge of the local geography obtained through such activities as farming, construction and hunting. During our summer 2014 survey of southeastern Serbia, we found several raw material sources simply by asking local people if they had found any flint in their fields. Generally, they were able to identify flint when shown it and were more than willing to help us locate the raw material.

Toponyms may also aid in finding raw material sources. For example, places with the name *kremen* (literally flint) are areas which should contain some kind of flint. Flint was an important resource for its use as gun flints and fire starters in the 18th and 19th century and even up until the 1990s in some locations (Petar Milojević, personal communication). Due to its importance in daily life, areas with a large quantity of flint typically were named *Kremenac* or *Kremenica*. While there is no doubt that most of these locations contain flint, we did find that some places named *Kremenac* were actually limestone quarries. Despite this, it seems that towns or hills with the *kremen* toponym (which appear to be numerous in Serbia) would be good places to look for flint raw material sources.

Utility of Surface Scatters

The most obvious indicators of buried open-air sites are surface scatters or artifacts, especially those located in agricultural fields. There is great debate over what sort of conclusions can be derived from these artifacts and to what extent artifacts on the surface correlate with non-disturbed archaeological features below a plow zone (Navazo and Díez 2008). Nonetheless, they do at least signal the possibility of buried *in situ* archaeological deposits.

The most obvious use of artifacts from surface scatters involves finding temporally or culturally diagnostic artifacts. While these artifacts are not in a primary context, their identification provides valuable data on which hominin groups inhabited the landscape and at what time. By surveying agricultural fields for diagnostic artifacts, we may be able to increase the number Paleolithic finds available for analysis. This is especially important if we are able to find artifacts representing Aurignacian or other Early Upper Paleolithic industries. Thus, employing field walking to locate artifact surface scatters may allow us confirm whether or not people were present to any appreciable degree during different periods.

A central challenge with surface artifact scatters involves understanding the relationship between them and possible intact archaeological sites under the surface. While there is an intuitive appeal to the idea that artifacts may be in their original context under a surface scatter this cannot be assumed. One issue involves understanding the processes which resulted in the surface scatter. Were artifacts brought to the surface as the result of natural processes (such as erosion), human activities (such as plowing a field), or are these features lag deposits? If the artifacts are located on the surface because of erosion, it may be possible to locate the source of intact sediments and find a portion of the site in its original context. On the other hand, if the artifacts have always been on the surface (forming lag deposits) there are probably no related archaeological sites under these surface scatters. Such lag deposits can be identified based on the conditions of artifacts: they will usually contain flakes which are highly patinated, artifacts from multiple time periods, or both.

However, the most controversial aspect of analyzing open-air surface scatters (especially those caused by plowing) is their relationship to subsurface sites. Some issues to consider are whether plowing has gone deep enough to disturb an entire site, or, if some portion of the site is still intact, how the plowing scattered artifacts from the disturbed portion of the site. Some experiments have been conducted to test the relationship between surface scatters and buried archaeological deposits (Roper 1976; Trubowitz 1978; Ammerman 1985). These studies seem to indicate that artifacts on the surface are more dispersed than they are in their original context, probably due to the processes that bring them to the surface. Moreover, only a small portion of artifacts actually reach the surface, with the rest remaining in the plow zone. Recent research by Navazo and Díez (2008) have reached similar conclusions, while also noting that horizontal displacement of artifacts from their original position can range between 0 and 100 meters when mechanical tractors are the agent of disturbance.

On the face of it, these experimental results seem to discourage the use of artifact scatters to locate open-air sites. However, Navazo and Díez also reported that it was still possible to delineate site boundaries from surface scatters, even if they were more spread out than the original site. If this is the case, artifact scatters could be delineated in agricultural fields and then subsurface testing using shovel test pits could locate portions of a site unaffected by plowing.

GIS Modeling

Constructing a GIS model to locate open-air sites requires several different sources of data. The most important set of data are those derived from the soil surveys, which will help predict areas on the landscape where soils should be old enough to contain Pleistocene age sites. Based on the information in Table 1, Alfisols are the only soil order typically found in Serbia old enough to contain Pleistocene sites, which should greatly constrain possible survey areas. Geological data help to exclude landforms that are inappropriate for surveying, such as areas containing recent alluvium or rock outcrops. Several other variables also need to be included in the GIS model, including land use and vegetation data. Both of these variables can be easily obtained from geospatial data sources and allow us to avoid surveying areas that are either densely forested, contain wetlands, or are in urban areas.

A separate GIS model must be created to locate raw material sources. This model would use data from geological maps which show the locations of rock types suitable for producing stone tools. Data from Topographic maps can also be used to locate villages and landforms that use variants of the *Kremenac* toponym, which can be displayed as points in the GIS model. This model will also allow one to explore the relationship between toponyms such as *Kremenac* and geological features containing useable raw materials.

Typically, models for predicting site locations are based on finding patterns in model variables from known sites: one analyzes the locations of these sites to understand how they are correlated with variables such as elevation, slope or aspect. Because there are so few open-air Paleolithic sites presently known in Serbia it is not currently possible to infer parameters for variables that could be used as elements in a predictive model. Instead, these two models using raw material locations and soil/landforms can serve to definitively exclude areas where there is a very low probability of finding Paleolithic sites, thus permitting a far more intensive systemic survey of the parts of the landscape most likely to contain Pleistocene sites. However, data on the location, elevation, slope, landform type and hill slope location of sites, associated surface scatters, or raw material sources collected during surveys can be used to create predictive models in the future.

Future Research and Conclusion

It is clear that many sources of information can be used to model possible locations for Middle and Upper Paleolithic open-air sites in Serbia. In the future, these data will be applied to several survey locations which probably have the best chances of containing open-air sites, including the Nišava River Valley, the Južna (Southern), Zapandna (Western) and Velika (Great) Morava River Valleys. The Morava River system is especially important to survey as the main valley may have served as an alternative inland migration route for hominins who traveled through southern Turkey and crossed an exposed land bridge into Southern Greece (Kuhn et al. this volume). From there, hominins could have traveled through narrow valleys in Greece and Macedonia to reach the Morava Valley before continuing to the Danube River and into Europe.

Future research will focus on filling in gaps on available raw material sources and documenting the location of open-air archaeological sites in the river valleys. By utilizing the modeling framework suggested in this paper, we can minimize the time it takes to survey these areas while also maximizing the likelihood of finding raw material sources, surface artifact scatters and open-air Paleolithic sites.

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NEW DATA ABOUT THE LOWER AND MIDDLE PALAEOLITHIC IN THE WESTERN MORAVA VALLEY

Dušan Mihailović, Stefan Milošević and Predrag Radović

Abstract: A relatively small number of Lower and Middle Palaeolithic open-air sites have been registered in southeast Europe. There are only two regions where sites from this period have been systematically surveyed, and where they have been encountered in considerable numbers: the valley of the Pineios river in Greece and northern Bosnia. Not a single site with significant concentration of finds has been found in Serbia and isolated artifacts ascribed to the Middle Palaeolithic were found at few sites. All this has changed dramatically in recent years when a large number of sites with finds from the Lower and Middle Palaeolithic have been recorded in the zone from Čačak to Kraljevo in the West Morava valley. The site surveying in the area has opened an entirely new perspective in the investigation of the Palaeolithic in this part of the Balkans.

Key words: Palaeolithic, open air sites, Serbia, Balkans

Introduction

The first Palaeolithic artifacts in the West Morava valley were recorded in 2008 at the site Vlaška Glava in the village Samaila near Kraljevo. A team from the National Museum in Kraljevo had carried out detailed surveying of the site by 2009. On that occasion 250 artifacts were gathered and 97 of them were located using GPS system. Preliminary results of the analyses of gathered material were published in the very same year (Mihailović, Bogosavljević-Petrović 2009).

Systematic surveying of the site continued in 2010 in cooperation with the Faculty of Philosophy in Belgrade and the National Museum in Kraljevo. All fields at the site Vlaška Glava have been examined in detail and positions of artifacts were precisely recorded. Two trenches, 2 x 2 m, were opened on the lot below the village cemetery where most of the material was encountered. It was concluded, on that occasion, that finds appear only within plowed and partially humified soil but that they are lacking in the yellowish clayey sediment under the surface layer. Then it was concluded that this sediment probably belongs to the Miocene or Early Pleistocene limnic terrace to which, judging by the geological map (Marković et al. 1968), the elevation Vlaška Glava also belongs.

The following year detailed investigations into the terrain around Vaska Glava began. It was concluded that artifacts appear not only on the top of the elevation but also on its slopes toward the Grabovac stream and the West Morava. However, we realized in the course of investigations that Palaeolithic artifacts have also been discovered during earlier surveying of Čačak-Kraljevo valley carried out by the National Museum in Čačak. As it was established that those sites are situated at approximately the same relative altitude in relation to the river as Vlaška Glava we decided to explore the highest Pleistocene terraces (t3, t2) within entire area between Kraljevo and Čačak, and to check in detail the fields located on the frontal ends of the terraces facing at one side the West Morava river valley and at the other side the valleys of streams which run from the Jelica Mt. to the West Morava.

It turned out that Palaeolithic artifacts appear at almost all selected locations at the altitude between 240 m and 260 m above sea level (Fig. 1). Most of the fields yielded up to five artifacts, while at some sites over a hundred artifacts were encountered. These are Kosovska Kosa near the village Zablaće, Vojnovića Brdo in the village Ježevica and Kremenac in the village Viljuša. A few locations on the Pleistocene terraces on the left bank of the West Morava were also examined during the same campaign. A considerably smaller amount of artifacts has been found there, probably because deposits of chert do not appear in the geological structure of the terrain on that bank, in contrast to the terrain on the right river bank.

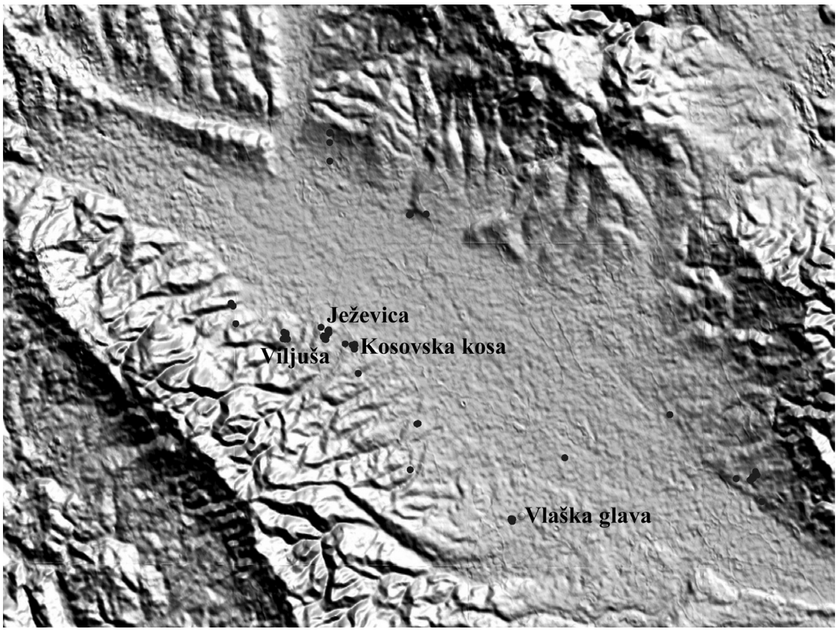

Figure 1. Lower and Middle Palaeolithic sites in Čačak-Kraljevo basin.

Surveys conducted in 2012 aimed at establishing .whether or not Pleistocene sediments with paleontological and archaeological finds appear on the left bank of West Morava in the zone from Miločaj to Sirča. It has been concluded that fossilized wood remains, which probably date from the Pleistocene, appear in sandy sediments of Madjarski Potok and Višnjevac and that there are Palaeolithic artifacts in the fields between those two streams.

Geography and Geology of Čačak-Kraljevo Valley

The Čačak-Kraljevo (or West Morava) basin is the largest Neogene intramountain limnic basin in Serbia. During younger part of the Pleistocene, limnic regime of this basin had transformed into the river regime, which still exists. The average thickness of lake sediments is around 100 meters and river terraces and alluvion are 8-12 meters thick.

Earlier Quaternary (lake) sediments consist mainly of clayey sands, sandy clays, ferriferous sands and gravels without conspicuous stratification (Fig. 2). They were discovered on the left bank of the West Morava, while at other sites they were usually discov-

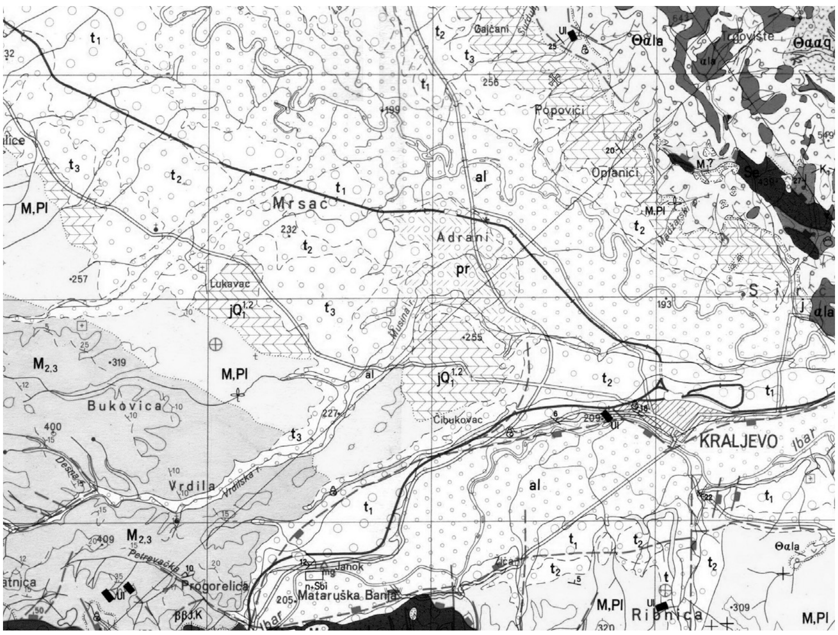

Figure 2. Geological map of the Čačak-Kraljevo basin.

ered by drilling underneath fluvial deposits. From the limnic phase of sedimentation come finds of fossil flora and fauna. Sandy clays of Mađarski potok yielded characteristic fossil flora (*Betula* sp., *Alnus kefersteini*, *Fagus pliocenica*, *Carpinus grandia*, *Ulmus longipholia*, *Ulmus carpionoides*, *Ulmus* sp., *Juglans* sp., *Zelcova ungeri* and *Platanus* sp.), which grew in the humid forests of temperate zone in the interval from the end of the Pontian age (end of the Miocene) to the Middle Pleistocene.

Remains of the fossil mammals *Rhinoceros* sp., *Equus caballus* and *Mammuthus primigenius* have been found in the gravels overlaying sediments with flora in the area of village Popovići and in Mađarski Potok. The series is identified on the basis of these finds as Lower-and/or Middle Pleistocene (Marković et al. 1968). During subsequent (river) phase four terrace horizons made of pebbles, sands, clay, loessoid sediments and red soil were created on valley slopes of the West Morava. Three upper terraces are of Middle and Upper Pleistocene age, while the lowest one is certainly of Holocene age. All terraces have identical profiles, at the bottom consisting of gravels and sands and on top loess-like clays.

Samaila – Vlaška Glava


Figure 3. Vlaška glava – a view from the North.

The largest amount of artifacts at Vlaška Glava was gathered within lot 995, almost on top of the hill and next to the village cemetery (Fig. 3). Preliminary analyses of raw materials revealed that radiolarian chert of brown and dark red color, silicified magnesite, cryptocrystalline chert, chert of organogenic structure with aggregates of fossil remains and quartz had been used for knapping. Traces of cortex could be noticed on many artifacts, so it could be assumed that raw materials were obtained from secondary deposits in the vicinity. Primary deposits are located in the western part of Čačak-Kraljevo valley, in the Mesozoic formations of the Jelica Mt (Marković et al. 1968).

From the material gathered in 2008 and 2009 (250 pieces in total) a few types of cores were identified: a) tested pebbles (2 pieces), b) choppers (1 piece), c) ‘proto-Levallois’ and Levallois cores (6 and 1 piece), d) cores knapped by salami-slicing technique (1 piece), e) Kombewa cores (2 pieces), f) irregular cores on pebbles (6 pieces) and g) core fragments (1 piece).

Only one typical side-chopper with facets of knapping on the longer edge of pebble was found (Fig. 4). ‘Proto-Levallois’ cores are characterized by parallel facets and without traces of preparation of flaking surface (White and Ashton 2003), and three preferential and one centripetal core were also recorded. The Levallois core is of small size and it has a prepared platform and flaking surface. Kombewa cores were made on thick flakes and fragments of pebbles and some of them have faceted platforms.

Flakes retouched by shallow and semi-abrupt retouch prevail (25 pieces) among the tools (64 pieces) followed by denticulated and notched tools (13 pieces in total) and sidescrapers (11 pieces). Other types of tools are less frequent. Laterally retouched specimens prevail among the

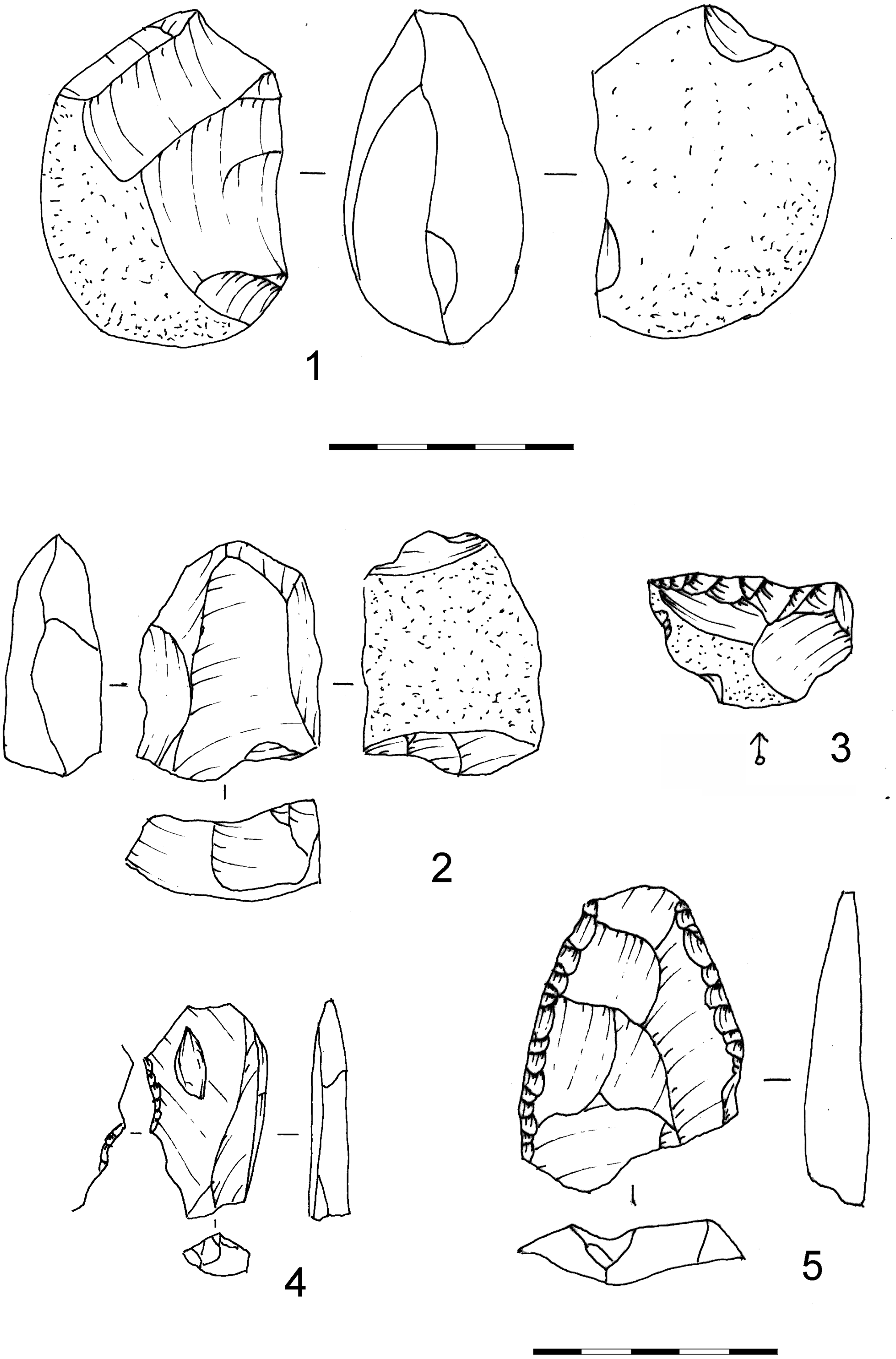

Figure 4. Stone artifacts from Samaila - Vlaška Glava: side-chopper (1), preferential core (2), transverse scraper (3), naturally backed knife (4), double scraper on Levallois flake (5).

sidescrapers: two bilateral sidescrapers, four lateral (three slightly convex and one straight), one latero-transversal (on dejete flake) and two transversal specimens were found. One partially retouched sidescraper as well as one sidescraper retouched by inverse deep and raised retouch were encountered.

Endscrapers are not standardized and there are specimens thinned by shallow surface retouch as well as pieces made on secondary used Kombewa cores. Flakes, which are retouched at the distal end by semi-abrupt, sometimes alternating retouch, are classified as retouched truncations and we also encountered one truncated faceted piece on an elongated flake. Burins are not characteristic and generally have one laterally or transversally oriented facet each. One combined tool (endscraper-perforator) made on thick flake was also found. Denticulated tools were made on diverse pieces and one of them was made on the large-sized Levallois flake. When notched tools are concerned there are also specimens on Levallois flakes and notches of Clactonian type were also recorded.

Zablaće – Kosovska Kosa

Kosovska Kosa is situated in the vicinity of Zablaće, between Srejovića stream and Ježevica River at the location where the latest Miocene limnic terrace (M3) meets one of the highest Pleistocene terraces (t3). At the bottom of Kosovska Kosa is a paleo-canal and a large quantity of chipped stone artifacts was gathered on its sides (Figs. 5, 6). A large number of finds was recorded on the other side of the canal as well but also on top of the slope that already belongs to the village Ježevica.

Kosovska Kosa was surveyed in detail in 2011 and the position of most artifacts was located using GPS. The spatial distribution of artifacts indicates that the accumulation of finds was not influenced by erosion but that there were remains of the settlement situated on the canal bank. The assemblage gathered in 2011 (157 artifacts) consists of 16.6% cores and choppers, 44.6% flakes, 10.8%

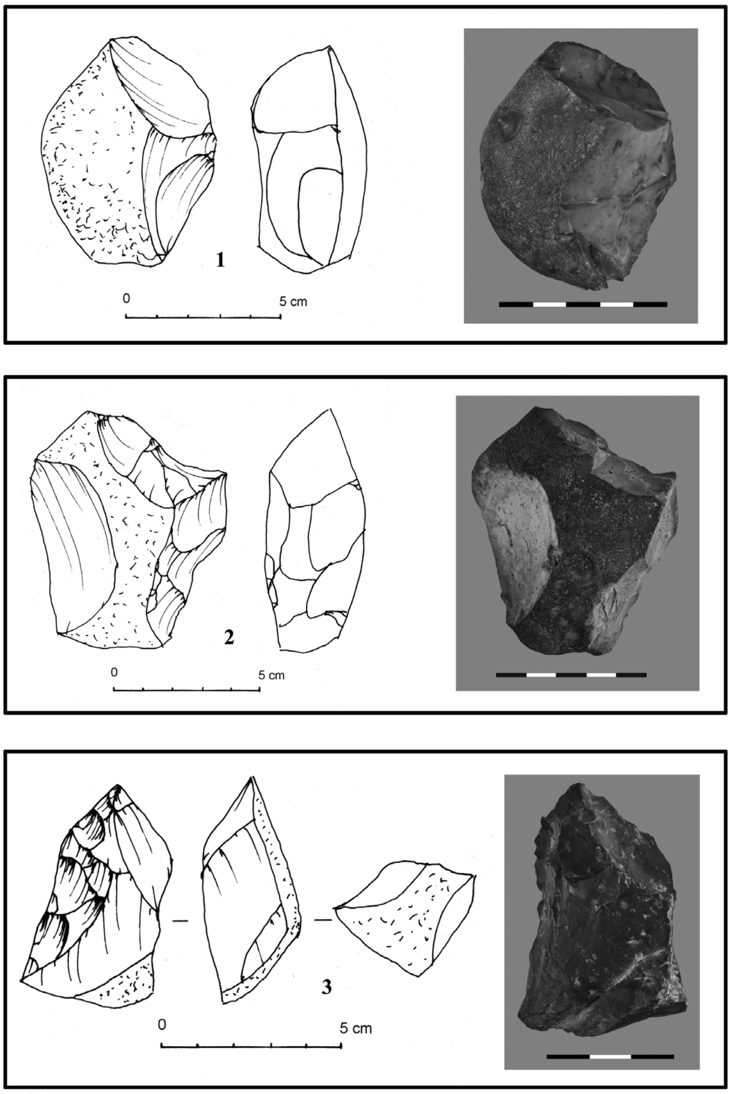

Figure 5. Kosovska Kosa: side-choppers (1, 2) and Quinson point (3).

chunks, 19.7% retouched tools and 8.3% chips and tiny fragments.

Cores are generally of polyhedral type but there was also one ‘proto-Levallois’ core of preferential type. Most choppers could also be identified as cores and specimens knapped on the side (side-choppers) prevail. Some artifacts made from pebbles could be classified as tools: e.g. one point of Quinson type made on a pebble fragment. Flakes are generally asymmetrical, often with cortex and diagonally oriented platform, which does not reveal traces of preparation. The only exception is one Levallois flake, which, judging by luster and polish could have been brought from another place. Prevailing tools are denticulated tools, asymmetrical sidescrapers and endscrapers and retouched flakes.

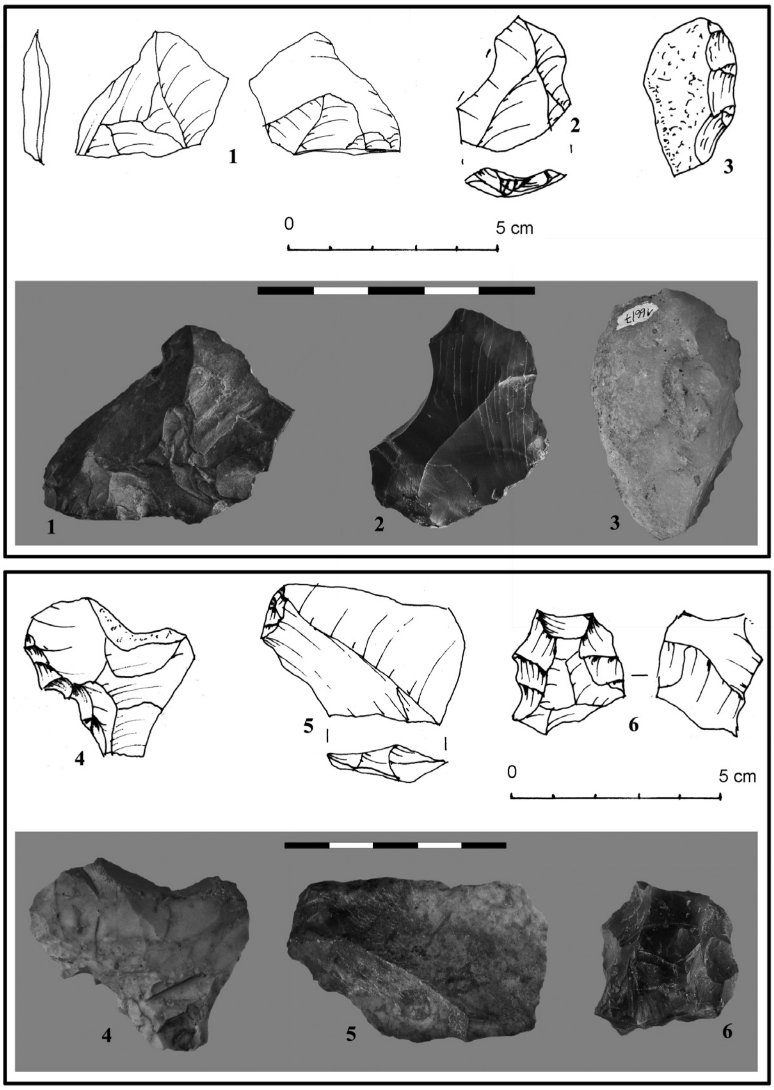

Figure 6. Stone artifacts from Kosovska Kosa: ventrally thinned flake (1), Levallois flake (2), denticulate tools (4, 6), endscraper (5).

Ježevica – Vojnovića brdo

Finds have also been recorded in the vicinity of Zablaće in the continuation of the Miocene terrace where Vojnovića brdo in Ježevica and Kremenac in the village Viljuša are situated. Artifacts were also found in the fields at a somewhat lower altitude above sea level (240-245m) at the site Vapa – Makva below Vojnovića brdo.

Around one-hundred finds were gathered at Vojnovića brdo (Fig. 7). Cores are not as frequent and among them are interesting Kombewa cores on pebble fragments and thick flakes with visible facets of knapped flakes on the ventral side. Some specimens have prepared platforms, while on some pieces the flaking surface (on the ventral side) is almost entirely covered with facets. One of these cores was subsequently transformed into a transversal sidescraper. Flakes are generally irregular, but there were also recorded flakes with broad platforms that could be identified as Levallois flakes. Tools are scarce and simple retouched flakes and denticulated tools prevail. There were also a few partially retouched sidescrapers.

Material from Ježevica and Viljuša reveals similar characteristics and only the different one of these assemblages is the assemblage from Makva, where tools on elongated flakes and also one bifacially chipped knife were recorded together with a few Levallois artifacts. The artifact assemblage from this site could not entirely be ascribed to the Palaeolithic with certainty: diagnostic artifacts are not numerous and few small fragments of prehistoric pottery were found at the same location. This is also the same situation with two bifacial tools of cleaver type discovered at other locations.

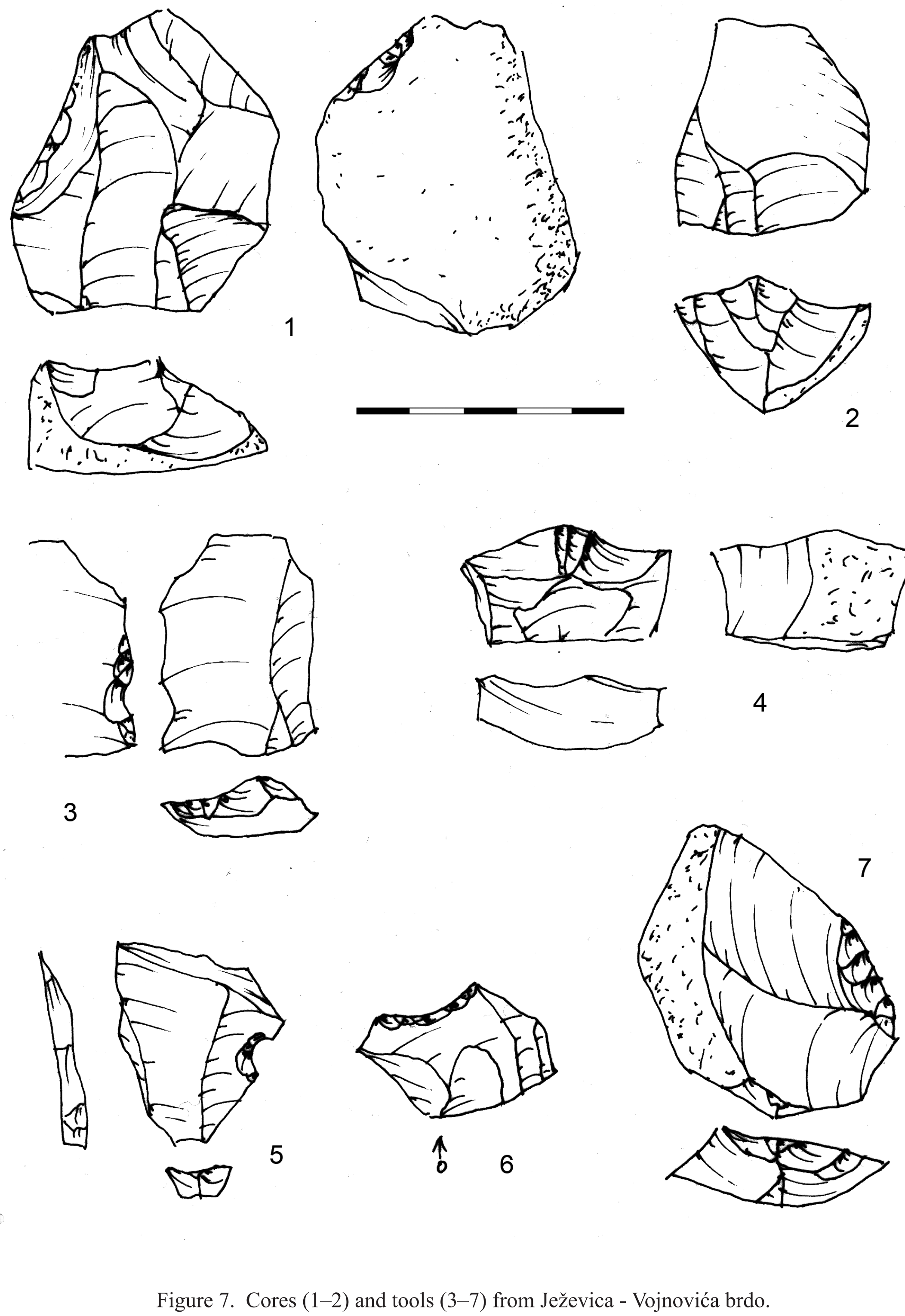

Figure 7. Cores (1–2) and tools (3–7) from Ježevica - Vojnovića brdo.

Variability of assemblages and parallels with the industries from the neighboring regions

It is quite obvious that both a Lower Palaeolithic and Middle Palaeolithic component exist in the industries discovered at the sites in the West Morava valley. The Lower Palaeolithic is most conspicuous at Kosovska Kosa and is apparent in the high incidence of choppers and low incidence of Middle Palaeolithic elements, while the Middle Palaeolithic appears in the material from Vlaška Glava where the Levallois artifacts and sidescrapers are most numerous. However, there are also many similarities between these sites (including also Vojnovića brdo), which are first of all visible in the connection of the Levallois technology with "chopper" technology and Kombewa technique but also on a typological and attribute level when we have in mind style of sidescraper making and frequency of the Charentian elements.

If we take into consideration the remains from all three sites it is obvious that an identical method was used in knapping technique: using a technique of chopper knapping the platform was created on pebbles, while the Kombewa technique was used for making thick flakes whose ventral side played the part of flaking surface on cores. Platform on choppers and Kombewa cores was faceted before knapping and a series of parallel flakes was struck without special preparation of the flaking surface and core perimeter. It was practiced only in the advanced phase of reduction when 'proto-Levallois' cores were transformed in cores of Levallois or discoid type.

The question could be asked how much differences in the structure of assemblages from the sites in the West Morava valley could be explained from the aspect of difference in the character of settlement and functions of habitations and post-depositional processes, which could result in mixing of the material, and how much from the chronological aspect:

a) The fact that there is a direct correlation between the structure of assemblages and the distance of sites from the primary deposits could speak in favor of a functional explanation. Lower Palaeolithic elements are more prominent at the sites in the vicinity of Kraljevo where primary and probably also secondary sources of raw materials (at the confluence of waterways flowing from the Jelica Mt.) are located, while Middle Palaeolithic elements are more frequent at the sites outside that area. In this case, the Lower Palaeolithic character of the industry from Kosovska Kosa could be explained as a consequence of intensified workshop activity at that location (regarding primary decortication, knapping of usable blanks for tool production, etc.)

b) Considering the context of finds we must also take into consideration the possibility of material mixing, as long as the artifacts are not found in reliable stratigraphic context.

c) The possibility that assemblages are relatively homogeneous and that they at least partially reflect the period from which they are originating is also plausible, especially considering common elements in knapping technology. In this case, however, the question could be asked to which period and industry it could be related.

Similar industries have not been ascertained so far in the Balkans. Choppers and the Kombewa technique appear in the Lower Paleolithic of the Balkans at the sites dated to the period between 200 and 300 ka (Dealul Guran, Yarimbourgaz, Rodia), where a highly simple unidirectional and centripetal knapping technique has been confirmed, while the Levallois technique does not appear (Tourloukis 2010; Iovita et al. 2012). Cores and tools on pebbles appear also at Lower and Middle Palaeolithic sites in central Europe but at those sites Levallois elements are also lacking (Kretzoi, Dobosi 1990; Moncel 2003; Mester and Moncel 2006). On the other hand choppers are generally lacking at the Middle Palaeolithic sites where the Levallois technique appears. This is also the case with upper layers at Velika Balanica (2a-2c) where Kombewa flakes where confirmed together with Charentian elements and Levallois artifacts (Mihailović 2008, 2009).

A technique resembling 'proto-Levallois' in a way it is defined in western Europe (White, Ashton 2003) appears at the site Zobište in northern Bosnia dated between 97.500 B.P. ± 7000 and 85.500 B.P. ± 8500 (Montet-White et al. 1986; Baumler 1987). Pebbles were knapped without special preparation, first from one and then from different directions and they were then transformed in small-sized discoid cores (Baumler 1987). Levallois artifacts and sidescrapers prevail at Vlaška Glava (but also at most other Lower Palaeolithic sites in the Balkans). Choppers and the Kombewa technique, however, are not confirmed but flakes of the type *éclats debordants* and pseudo-Levallois points were encountered in considerable quantity and they have not been confirmed in larger amount in the West Morava valley at least for the time being.

Levallois technology was also recorded in layers XXXI-XXIV at Crvena Stijena dated to the period from MIS 6 to MIS 5e and tapering of tools using ventral retouch was also encountered (Kozlowski 2002). Still, as in previous case, Lower Palaeolithic elements are almost entirely lacking. A similar situation is evident in the 'basal Mousterian' of Asprochaliko dated to 90-100 ka (Bailey et al. 1992; Gowlett and Carter 1997). Certain parallels could be, however, drawn between Vlaška Glava and the lower layers of Teopetra (Panagopoulou 1999) that are dated to the transition from MIS 6 to MIS 5 (Valladas et al. 2007) and where chopping tools as well as sidescrapers of the Charentian type were also found together with Levallois artifacts.

Nevertheless, parallels are most prominent when Lower Palaeolithic, mostly Late Acheulian sites in the Near East, in the Caucasus and even in western Europe are concerned (Bar-Yosef 1994; Turq 2000; Shea 2008; Doronichev and Golovanova 2010; Adler et al. 2014). There along with bifaces also appear choppers as well as the products of flaking obtained by using the Levallois and Kombewa techniques with more or less prominent incidence of Clactonian and Charentian elements and points of Quinson type. If this impression is correct, the question arises whether in lacustrine and fluvial setting in this part of the Balkans sites with early Levallois technology and bifacial stone tools could also be expected. We think judging by the finds from Rodafnidia in Lesvos (Galanidou et al. 2012) and even more from Kokkinopilos in Epirus (Tourloukis 2010) that this is quite possible despite the fact that Acheulian has not been confirmed with certainty anywhere in the Balkan interior as well as in most of central and eastern Europe.

Conclusion

When we take everything into consideration it could be assumed that the assemblage from Kosovska Kosa dates from the late phase of the Lower Palaeolithic, while finds from Vojnovića brdo and Samaila could date from the same time or a somewhat later period. These assemblages could coincide from the chronological point of view with the period between 300-400 ka when Levallois technology appeared for the first time in Europe until around 120 thousand years (i.e. to the end of MIS 5e) when choppers and Lower Palaeolithic elements definitely disappear from the Middle Palaeolithic industries in the Balkans. It is possible considering indications that the Balkans had been most densely populated in the interglacial periods that Vlaška Glava dates from MIS7 or 5e and Kosovska Kosa from MIS 7 or from some earlier period although it is not impossible that West Morava valley was also inhabited in the glacial periods. It is also quite possible that all sites from the highest West Morava river terrace date from the same period and that differences in the structure of artifacts is first of all the result of differences in the character of settling of distinct locations.

It is, however, important to emphasize that these conclusions are not final but only hypothetical and that it is necessary to invest further efforts to find artifacts in stratigraphic context, in layers where faunal remains are also preserved. For that matter it has been planned to investigate locations in the West Morava valley where layers with sands are preserved as well as to expand investigations to the lower course of the West Morava and South Morava valley. Preliminary surveying results reveal that sites dating from the Lower and Middle Palaeolithic could also be expected in that area.

Note

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CRVENKA-AT– PRELIMINARY RESULTS FROM A LOWLAND AURIGNACIAN SITE IN THE MIDDLE DANUBE CATCHMENT

Wei Chu, Thomas Hauck and Dušan Mihailović

Abstract: The Middle Danube catchment is key when it comes to our comprehension of migration patterns of anatomically modern humans into Europe. However much of our current understanding of the region is inferred from karstic and upland sedimentary archives that may represent a biased view of early human spatial occupation. To begin rectifying this, in 2014 we relocated and sampled the previously known lowland Aurignacian findspot of Crvenka-At (Vršac, Serbia) as well as conducted a geoarchaeological prospection in the Serbian Banat plain. Our results confirm previous finds suggesting that this locality may represent a multiple-occupation Aurignacian site. If this is indeed the case, it means that early modern humans, during their initial settlement of Europe, may have exploited a wider range of ecological and topographic settings than previously supposed. At a minimum, our findings confirm that a more intensive exploration of the lowland areas of the Middle Danube catchment is essential to the formation of a better picture of the early settlement of modern humans in Europe.

Key words: Palaeolithic, Balkans, Banat, Aurignacian, At-Crvenka

Introduction

It is widely believed that the initial settlement of Europe by anatomically modern humans originated from an African source population, but the timing, trajectory and conditions of this migration are still poorly understood (Stringer 2002). The current paradigm holds that one potential corridor along which anatomically modern humans migrated into central Europe was the Danube catchment where riparian zones served as important migration conduits (Conard and Bolus 2008; Kozłowski 1992).

An area central to this discussion has been the Banat, a historic region in Central Europe currently divided among Romania, Serbia and Hungary. Within the Middle Danube catchment, the Banat is impor-

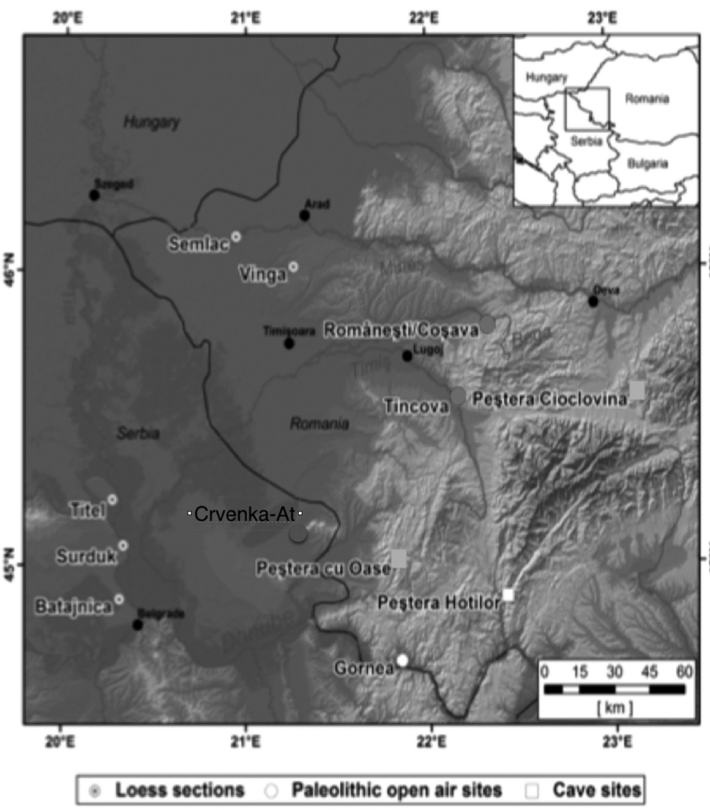

Figure 1a. The Banat: Regional setting, positions of selected loess sections, Paleolithic open air sites and cave sites (modified from Kels 2014).

tant for the emergence of the Upper Paleolithic in Europe as it shows variable topography and environments that hold a key geographical position in relation to the mainstream model proposed (Fig. 1a).

In recent years, the Banat has been of high palaeoanthropological importance, in no small part due to the finds at the Peștera cu Oase and Peștera Cioclovina, two caves that have yielded among the earliest securely dated remains of modern humans in Europe (Soficaru et al. 2007; Trinkaus et al. 2003). Re-analysis of the open-air sites of Româneşti-Dumbrăviţa, Coşava and Tincova, have also highlighted the archaeological prominence of the Banat (Anghelinu et al. 2012; Sitlivy et al. 2012a; Sitlivy et al. 2012b). Additionally, these sites and other loess sections provide us with a plethora of archives to help us understand the palaeoenvironmental record of the earliest presence of modern humans in Europe (Kels et al. 2014; Schmidt et al. 2013).

In spite of this, our understanding of the Banat remains geographically limited, as research has mainly focused on sites along the western foothills of the Carpathian Mountains. Indeed, all of the early Banat archaeological sites (and most sites within the wider Pannonian Basin) are located within 200-300 m A.S.L altitudinal belt (Hauck et al. in prep). All are embedded within a soil complex hypothesized to be the remnants of a forest steppe that persisted in the Carpathian foothills during MIS 3 (Kels et al. 2014). Meanwhile, the Northern Serbian plain, a key geographic constituent of the Banat, has received little attention, due to either 1) a true absence of early archaeological sites 2) a problematic sedimentological archive or 3) limited systematic research (Fitzsimmons et al. 2012; Iovita et al. 2013).

In consideration of this third possibility, we embarked on a new survey and preliminary re-excavation campaign in Northern Serbia in the vicinity of Vršac, Vojvodina for two weeks April 2014. This work resulted in the re-discovery of the Aurignacian site of At (henceforth At II) as well as a new locality (At I). Our results suggest that early settlers along the Danube catchment may have also exploited lowland areas of the Banat.

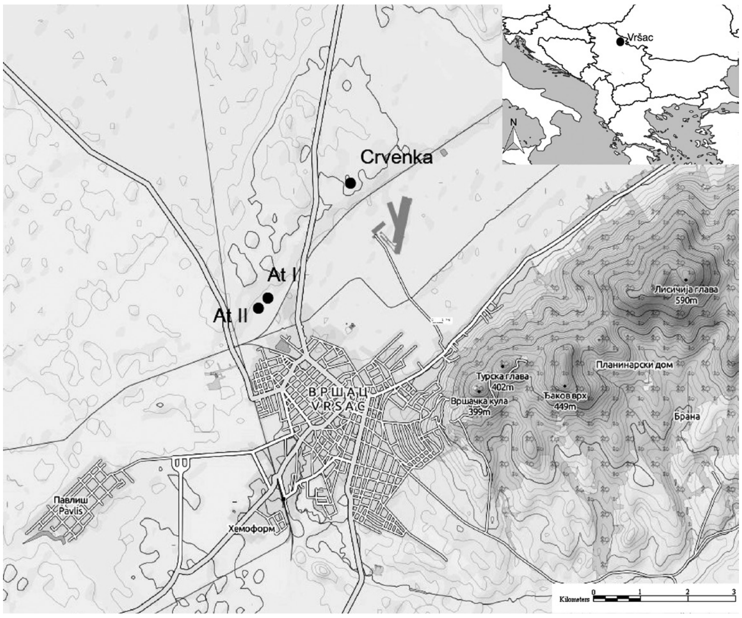

Figure 1b. The location of Palaeolithic sites in the vicinity of Vršac.

Previous work

Geologically, the Crvenka-At localities (45° 08' 126''N, 21° 16' 820''E) are located in the southern belt of the Pannonian Basin approximately 3 km north of the town of Vršac and the Vršac Mountains. The archaeological sites are all located within an approximate 1 km stretch of a sand ridge (up to 93 m a.s.l) that separates the depressions north of Vršac and east of Alibunar (Fig. 1b).

Middle and Upper Palaeolithic artifacts from the northern foot of Vršac Mountains have been well known since the end of the 19th century as a result of urban expansion and sand exploitation (Mihailović et al. 2011); later finds from the At-Crvenka and Balata localities were only systematically collected by R. Rašajski (1952-1978; Mihailović et al. 2011). The technological homogeneity of artifacts found near the At locality led to a systematic excavation in 1984 by I. Radovanović who identified three separate archaeological levels none containing more than 228 pieces (Radovanović 1986: 12).

Mihailović broadly ascribed these assemblages to the Aurignacian, specifying both “typical” Aurignacian layers (IIa at At and IIb at Crvenka) as well as “Krems” style Aurignacian layers (Layer IIb at Crvenka; Mihailović 1992). Due to the unsystematic nature of the excavation of some of these artifacts (those that were collected by Rašajski) and the relatively small assemblage numbers collected during excavation, we felt that empirical support for such interpretations could still be strengthened by renewed research, specifically by:

- Obtaining a secure age model for the site.
- Understanding the genesis of the site’s sediments and the subsequent site formation processes of the various archaeological levels.
- Securing data pertinent to the habitat/palaeoclimate of the area notably by recovering faunal/botanical remains.

The aim of this fieldwork was therefore to clarify these outstanding issues by relocating the site and analyzing its sedimentary/environmental context through a series of test pit excavations and sediment sampling for chronostratigraphic dating and sediment characterization.

Material and Methods

To better understand the context of the artifacts at At, we installed two new trenches at the margins of two pre-existing sand pits (Fig. 2). One trench (2x1 m) was dug at At I so as to obtain an idea of the subsurface and to correlate it with At II and the outcrops of Crvenka. A second 2x1 m trench (At II) was excavated to relocate the 1984-trench and again to correlate the stratigraphy with the trench at At I and the outcrops of Crvenka. All finds and the excavation area were piece-provenienced in a coordinate system using traditional analog methods as well as a total station.

In the absence of datable organic remains, luminescence samples were taken at all Crvenka-At profiles to temporally constrain the archaeological levels. Additionally, sedimentological samples were taken for grain size analysis, elemental analysis, as well as frequency-dependent magnetic susceptibility. These data can be used as a proxy for the content of magnetic minerals, and their relative grain size which can aid in the reconstruction of the palaeoclimate, sediment genesis (e.g. fluvial, lacustrine, aeolian) and to correlate between the sites and potentially other sections in the vicinity.

To locate additional natural occupation sites, we also undertook a land survey of the lowlands surrounding the Vršac region aimed at systematically locating sites based on geomorphic contexts. Given the near absence of sites in the area, we chose to focus our efforts on loess and loess-like sediments. The strategy that we employed was to examine pre-existing Pleis-

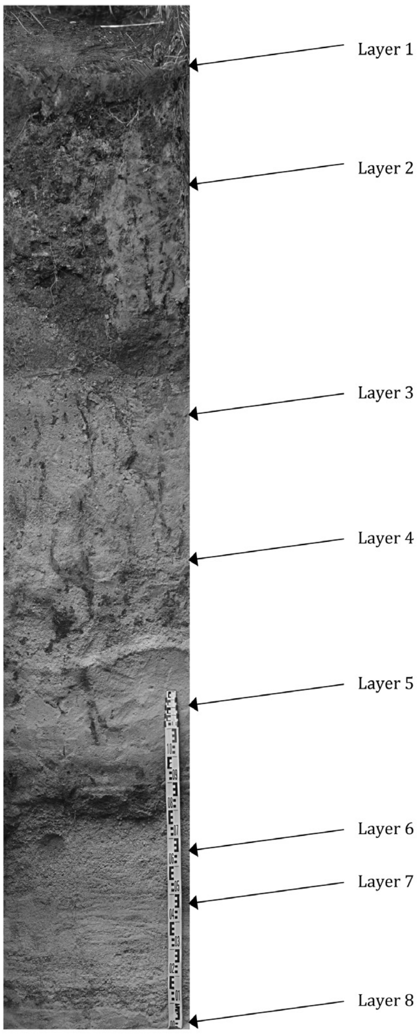

Figure 2. Orthophoto of test trench of At II

tocene loess sections (mostly remnants of construction work) as well as fields where loess sediments were brought to the surface as a result of agricultural plowing and erosion. Teams of 2-4 individuals undertook surveys and potential areas were identified with the use of geological and topographic maps.

Results

Finds

During the excavation of the two At localities (I and II), performed to relocate the previous excavation and sample specific sediments within the archaeological stratigraphy for luminescence dating and geochemistry, we were able to relocate the stratigraphic sequences in both At I and At II. In both instances, the stratigraphic sequences were in accord with descriptions from the previous 1984 excavations (Table 1).

Layers from At II	Depth (cm)	Description	Mihailovic	Archaeological finds
1	0-40	Heavily rooted brown-black topsoil	A humic layer: Heavily rooted brown-black topsoil	
2	40-140	Ochre, silty-fine sand	Loess/Sandy loess	
3	140-170	Silty, ochre horizon with krotovinas transitioning into pebbles	Yellow fine sand	
4	170-200	Poorly sorted, fine sand, with small gravels and mica	White fine sand	
5	200-214	Poorly sorted, lighter color	White coarse sand	
6	214-225	Finer well-sorted sand, without pebbles	White fine sand	1984, 2014
7	225-260	Humus rich clay, fining up	Clay	
8	260-283	Coarse pebbles and sand, quartz rich and light colored	Layer of sand below the clay	1984, 2014

Table 1. Levels at the At II locality.

Furthermore, we were able to locate the archaeological levels within Layers 6 and 8 that resulted in 19 new archaeological artifacts. The artifacts found within Layer 6 were a maximum of 4 cm and were non-diagnostic to a particular archaeological industry, though there were a number of pieces identified as possible blade fragments. Artifacts were heavily patinated and characterized by continuous bifacial edge damage as well as significant arête wear. By contrast, archaeological finds in the lower Layer 8 were found well preserved in fresh condition with little-to-no patination. Of the three flint artifacts found in that layer, one was a nosed endscraper manufactured on a local flint nodule (Fig. 3).

At present, luminescence samples have not yet been completed but sediment-magnetism samples were successfully processed; however, since they still require correction for instrumental drift, they are not discussed here.

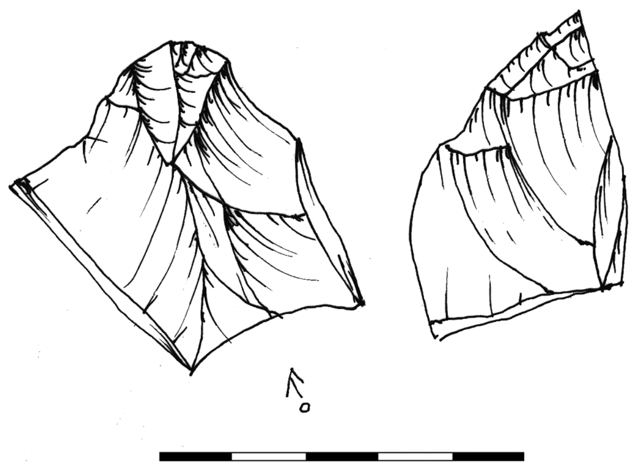

Figure 3. A nosed endscraper found at the beginning of Layer 8 at At II.

The land survey

The results of the land survey were disappointingly negative. Although a number of new loess outcrops were located and sampled for comparison to the Crvenka-At profiles, none of them revealed any artifacts.

Discussion

Our goal was to relocate, confirm, and obtain new data from the Crvenka-At sites to elaborate on lowland sites within the Banat region.

Based on the two test trenches from both At I and At II, we were able to arrive at six main findings:

1. Archaeological artifacts are indeed found within separate levels of the At-Crvenka sequence at multiple localities. These find layers correspond well to previous sedimentary descriptions (Mihailović 1992). These results indicate that the site extends over a greater area than previously thought—an area that may be delimited through future excavations.

2. Typologically, the new finds from the At localities confirm (or at least do not disprove) an Aurignacian authorship. This is in accordance with previous findings (Mihailović 1992) however due to our small sample size (n=19) these findings should be regarded with caution.

3. The sites are characterized by different layers of loess-like sediments, sand and coarse sand, which are poorly sorted. The angularity of these particles suggests short transport distances, possibly as a result of either fluvial or lacustrine action at the margins of the site ridge. These sediment descriptions are strikingly similar to those of previous findings (Table 1) however, we found more instances of bioturbation in the form of krotovinas in the upper levels. This may be a local observation, however a better understanding of these formations may help us to better understand the context of these later depositions.

4. We found that artifacts in the upper levels of the At layers were not fresh in condition. This indicates that they may have experienced some taphonomic disturbance consistent with hydraulic transport (Chu et al. 2013). This is consistent with the observations of the previous assemblage by Mihailović (1992) and suggests a local disturbance of the artifact assemblage.

5. Artifacts in the lower levels are of a fresher condition. This suggests that the lower levels may indeed represent an earlier occupation phase as posited by Mihailović (1992) and that these artifacts may have been deposited on an earlier, more stable surface. This indicates that future archaeological fieldwork should probably be targeted at excavating these levels in greater detail.

6. Regrettably, we were unable to locate new sites in the area through our land survey. This suggests that lowland sites in the Banat are either sparse, or may be difficult to access as they are buried by later sedimentation. From the deep context of the findings at Crvenka-At, we suggest that the latter is still a reasonable scenario.

There are still a number of limitations to this study. Firstly, many of our conclusions about the Aurignacian characterization of the site and its contemporaneity with upland sites should be confirmed with an absolute age model. Secondly, we only have a limited understanding of the assemblages' geological context. Understanding the sediments' origins would help us to better understand the site's formation processes and would enable us to perform a more detailed analysis of the lithic taphonomy. Lastly, we still do not have well-preserved faunal/floral remains that would enable us to better understand the environmental context of the site and the environmental challenges of the human occupation in the lowlands, which in turn would allow us to systematically compare them to the Banat upland sites.

Conclusion

The nature and timing of the first occupation of Europe is still widely underexplored, but it is clear that the Banat region in the Middle Danube catchment can provide numerous clues to the occupation of Eastern Europe by the first human settlers. While the upland section of this region has already proven to be a rich findspot, the lowlands are widely underexplored. The current sites at Crvenka-At, which provide some clues as to land-use patterns among early human settlers, indicate that a more systematic exploration of this area may yield compelling results. Indeed, understanding the relationship between these lowland sites (e.g. the At localities) and the upland sites may provide clues as to how the first settlers used the landscape.

Though our test trenches at the At localities confirmed findings that were still tentative and yielded a number of new artifacts, we still need to:

- Obtain secure dates for this assemblage.
- Correlate sections with loess and loess-like sediments in different geomorphological positions and combine sedimentological and geochemical methods for selected key sections.
- Improve our understanding of the flaked stone taphonomy.
- Understand how this site relates to the Middle to Upper Palaeolithic transition in the Banat region.

The initial results of the test excavation have confirmed the existence of a possible lowland Aurignacian site at At and have demonstrated the potential of this and other potential lowland sites to help elucidate many of the gaps in our knowledge of the human settlement of the Middle Danube Catchment. Filling in these gaps may provide us with the opportunity to get a detailed understanding of hominin responses to local climate, resources, and environment in a discrete region, which in turn may help us to extrapolate archaeological settlements in larger, less-researched areas (Richter et al. 2012).

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ŠALITRENA CAVE – TERRACE. PRELIMINARY INVESTIGATION RESULTS

Bojana Mihailović, Dušan Mihailović, Aleksandar Latas and Josh Lindal

Abstract: This text presents the results of investigations of the river terrace opposite Šalitrena cave. Remains from Upper Palaeolithic remains were recorded in a disturbed surface layer, while artifacts from the Middle Palaeolithic were encountered in the apparently intact geological strata recorded underneath. One leaf-like point was discovered (*Blattspitz*), which along with the find from Risovača and, perhaps, Koceljeva is one of the rare proofs for the existence of Middle Palaeolithic industries with leaf-shaped points in this part of Europe.

Key words: Šalitrena cave, Palaeolithic, Balkans, Mousterian, leaf-points

Introduction

Šalitrena cave is one of the richest multi-layered Palaeolithic sites in Serbia (Fig. 1). Two Gravettian, one Aurignacian and many Mousterian layers have been identified at this site, which has been investigated with interruptions since 1983 (Jež and Kaluđerović 1985). The total area explored so far is over 40 square meters (Mihailović 2008, 2013). Opposite the cave, on the bank of Ribnica river, there is a terrace where many chipped stone artifacts have been gathered in previous years (Fig. 2). Two small trenches were opened in the area this year. In the surface layer, artifacts from the Upper Palaeolithic and later periods were found, while in the layer below Middle Palaeolithic finds including one leaf-like point were encountered. This leaf-like point, along with the point from Risovača, is the only reliable evidence for Middle Palaeolithic industries with leaf-like points in Serbia. This discovery has made it possible to perceive, at least to a certain degree, the distribution of that type of industries in south Pannonia and in the north Balkans.

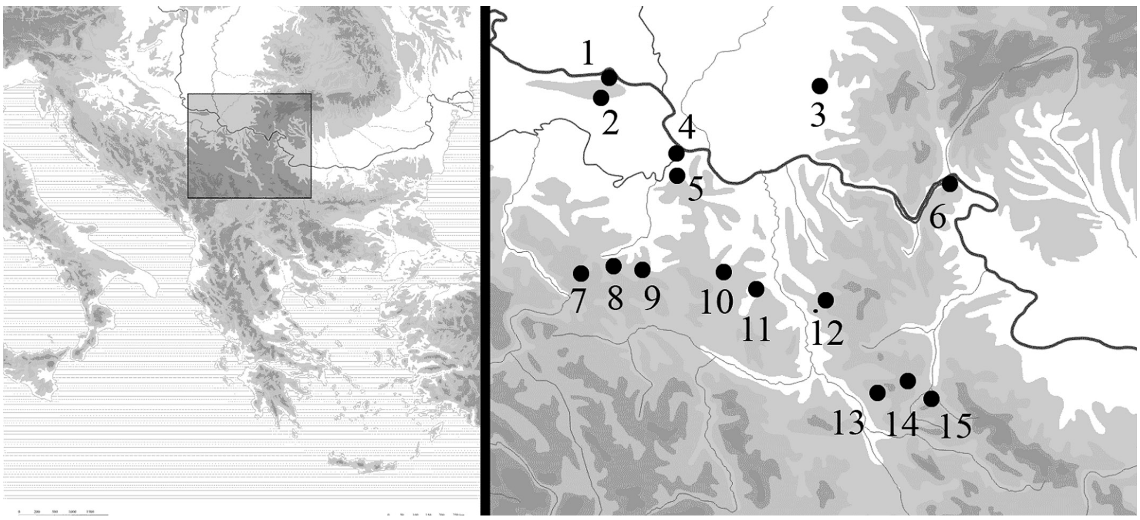

Figure 1. Palaeolithic sites in northern Serbia: 1 – Petrovaradin fortress; 2 – Cigan-Irig; 3 – Crvenka-At, Balata and other Palaeolithic sites in the vicinity of Vršac; 4 – Beljarica, Ekonomija 13. maj; 5 – Rušanj, 6 – Tabula Traiana cave; 7 – Drenaićka cave; 8 – Visoka cave; 9 – Šalitrena cave; 10 – Risovača; 11 – Pećina pod Jerininim brdom; 12 – Mirilovska cave; 13 – Markova cave; 14 – Pećurski kamen; 15 – Baranica.

Location, research and stratigraphy of the site

Figure 2. Šalitrena cave – view from the terrace.

Figure 3. Western profile in the trench A.

Ribnica belongs to the Kolubara basin and, along with Toplica and the Ljig river it is one of the basin's most important tributaries (Jovanović 1956). The river in its upper course created a canyon in upper Cretaceous limestones, which, along with the neighbouring terrain, are characterized by a significant quantity of chert. Three Pleistocene terraces are carved on the slopes of the valley, where facies of riverbed and inundation could be discerned. Riverbed facies in the lowest section of the profile consist of heterogeneous gravels, while inundation facies is characterized by the presence of clays and sands (Filipović et al. 1971). This is the situation in the Mionica basin. However, in the canyon section of Ribnica clayey and sandy sediment was deposited immediately on top of limestone rocks. That is also the case with the terrace of Ribnica opposite Šalitrena cave. At that location the erosion of Ribnica created a prominent meander and on its east side is the cave, while the terrace within the meander, 150 x 70 m in size, is around 20 meters higher than the riverbed.

Trench A, 1 x 2 m, was opened on the top of terrace directly opposite the cave entrance. Geological layers are investigated up to the depth of 2 m. Near the top of stratigraphic sequence is surface layer (1a) of dark brown color that is significantly disturbed by bioturbation, while near the bottom is reddish clayey sediment (layer 1b) which lays directly on the rocky ground. Large eboulis was recorded here and there in the lower layer (Fig. 3).

Trench B of the same size was opened in the north section of the plateau, which is rather sunny and from which there is a very good view to the cave and the Ribnica river canyon. A somewhat different stratigraphy has been recorded when we excavated this trench. Surface layer (1a) is of slightly smaller thickness and also consists of dark brown clayey sediment. Under that layer is one with sandy sediment (layer 1b) and underneath that is a layer with clayey sediment and small eboulis (layer 1c). This trench has been investigated to the depth of 1.50 m and rocky ground has not been reached.

The largest concentration of chipped stone artifacts in both trenches was recorded in the disturbed surface layer. It is crucial, however, that finds in lower layers (1b in trench A and 1c in trench B) were found in clearly defined stratigraphic context significantly below the surface layer. A small amount of very poorly preserved bones were found in layer 1c in trench B.

Integrity and cultural attribution of assemblages

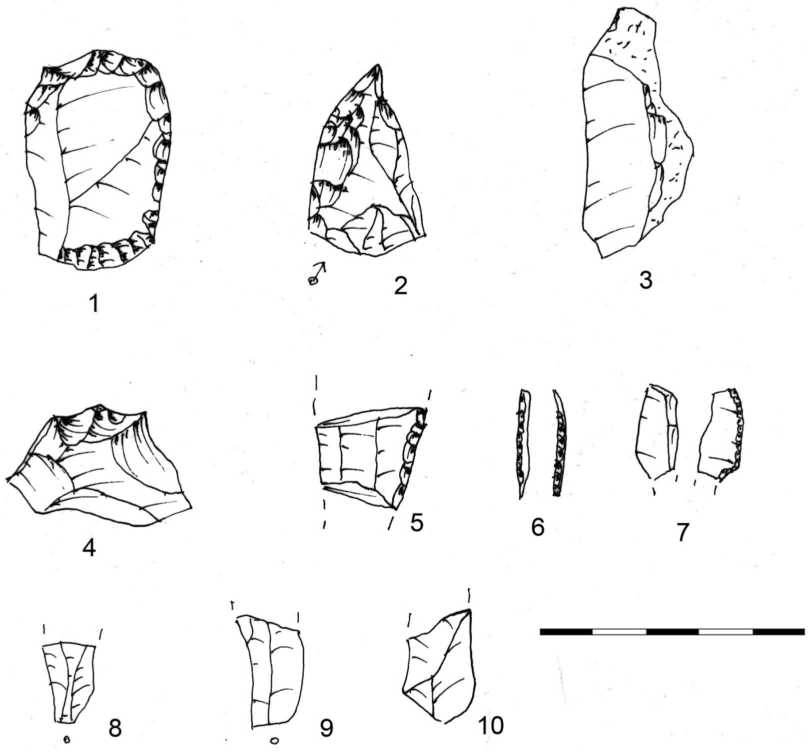

Figure 4. Stone artifacts from Šalitrena - terrace.

Assemblages of artifacts from surface layers in both trenches are not homogeneous and probably contain remains from different periods. Considering the situation in Šalitrena cave it is almost certain that a double end-scraper from layer 1a in trench A (Fig. 4.1) and an abruptly retouched point or burin spall from the same layer (Fig. 4.6) date from the Gravettian period. An inversely retouched bladelet, which resembles the Dufour bladelet (Fig. 4.7), could probably be ascribed to the Aurignacian as such bladelets have not been found in Gravettian layers in the Cave. Nevertheless, it is not certain as the retouched edge is curved on the proximal end and that is not characteristic of the Dufour bladelets. A transversally retouched denticulate sidescraper (Fig. 4.4) on the other hand dates almost certainly from the Mousterian period considering that it is typical and that similar sidescrapers have been found in the Mousterian layer in the cave. All this suggests the conclusion that the upper layers on the terrace were washed away by erosion and that subsequently the Middle Palaeolithic layer was also damaged due to human or biogenic activities.

For the time being everything indicates that layers 1b in trench A and 1c in trench B represent stratigraphically defined geological layers, which do not belong to the same horizon as the disturbed layer on the surface. In trench A there is a layer with eboulis near the top of layer 1b and artifacts were found underneath which means that there is distinct stratification also within this layer. All this does not mean that artifacts were encountered in original position, i.e. where they were initially deposited. Only when a larger area is investigated and when sedimentological analyses are completed would it be possible to conclude whether there were postdepositional disturbances, which could have had an impact on the distribution of finds.

Material from the lower layers, though not abundant, is relatively homogeneous. The Mousterian point from trench A (Fig. 4.2) dates certainly from the Middle Palaeolithic as is probably also the case with the leaf-like point from trench B (Fig. 5) considering that it has been found together with quartz artifacts, which have been found in Šalitrena cave only in the Middle Palaeolithic layers. A proximal blade fragment from the same level is not diagnostic for the Upper Palaeolithic. The blade edge has the back turned toward the ventral side and it suggests that it was probably struck in the course of core rejuvenation.

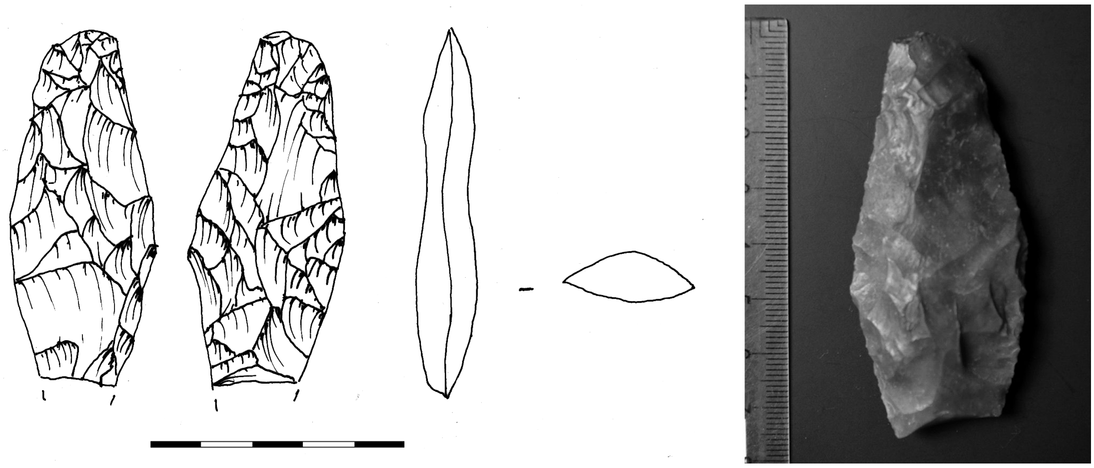

Figure 5. Leaf-like point from Šalitrena - terrace (trench B, layer 1c).

The leaf-like point from layer 1c in trench B is of particular significance considering that points of this type have been found in Serbia only in Risovača cave near Arandjelovac (Gavela 1969; 1988) and at an unknown site in the vicinity of Koceljeva (Šarić 2012). In Risovača, according to drawings, two bifacially retouched points have been found: one is of elongated Mousterian point shape, while the other (like the point from the site Šalitrena – Terrace) is rounded on one end and broken on the other. The point from Koceljeva, judging by the photograph, is less elongated and it is made of good quality black chert. There is yet another specimen in Serbia associated with leaf-like points. It is a retouched blade from Jerinina cave that is poorly illustrated and which J. Šarić without any argument (as there is not even superficial similarity) generally classified as that tool category (Šarić 2012)..

Points from Risovača were found in the Middle Palaeolithic context so it is understandable why Gavela insisted that Szeletian is a Middle Palaeolithic facies (Gavela 1969). Soon after that the situation changed as it turned out that this complex has a "transitional" character (Kozlowski and Kozlowski 1979; Allsworth-Jones 1990; Kaminska et al. 2011) and there are also Middle Palaeolithic industries in Bulgaria with leaf-like points that correspond even more to the situation in Serbia (Haesaerts and Sirakova 1979; Sirakov 1983).

Points from Šalitrena Cave – Terrace and one of the points from Risovača more resemble morphologically elongated points from Bulgarian sites (Muselievo, Samuilitsa II) than Szeletian specimens, although it must be emphasized that different variants of that tool type appear in both areas. For this reason material from the terrace could not be definitely ascribed for the time being to any of these two regional variants. It would be in any case too early as investigations at the site have just started.

Nevertheless, the find of a leaf-like point at the site Šalitrena cave – terrace already reveals that Middle Palaeolithic industries with leaf-like points were distributed not only in central Europe and the eastern Balkans but also in the peri-Pannonian area. Individual finds of tools of this type were recorded in Vindija cave in Croatia (Malez 1979; Karavanić and Smith 1998) and in Divje Babe I cave in Slovenia (Brodar 2009), while five bifacially retouched tools were found at the site Kamen in northern Bosnia (Basler 1979). When tools from the site Kamen are concerned it is not clear whether all found specimens could be classified as points or there are also bifacial sidescrapers (Ivanova 1979).

The chronology of sites with leaf-like points is also not sufficiently known. They are usually related to the late Middle Palaeolithic although they appear in Bulgaria as early as MIS 4 if not even earlier as is suggested by the finds from layer 10 at Kozarnika (Guadelli et al. 2005). It will be very important in that context to establish chronology of finds from the terrace, using OSL or ^{14}C method, if we find charcoal or preserved bones.

The relative chronology of finds from the terrace could be indirectly indicated by the finds from Šalitrena cave. According to preliminary examination of material from the Middle Palaeolithic layers it has been concluded that an industry with Levallois artifacts and transversal and dejete sidescrapers appears in upper layers (6a-6c) in the cave, and in lower layers (6c-6d) an industry with, among other things, also quartz artifacts, transversal sidescrapers and bifacial elements was recorded. Keeping in mind the fact that a quartz artifact was also recorded above the leaf-like point in trench B there is a possibility that this layer could correspond to the lower layers in the cave. Nevertheless, such assumption should still be confirmed.

Concluding remarks

Initial results of the investigation at the site Šalitrena Cave – Terrace confirm that the terrace had really been inhabited in the time when cave was inhabited but that layers from the Upper Palaeolithic and perhaps even later periods are eroded and disturbed. The Middle Palaeolithic layer is, however, preserved and the fact that diagnostic artifacts were discovered in both rather distant trenches suggests that investigations of this site have great potential.

There is great ambiguity about the stratigraphic context, chronology and cultural attribution of the sites with leaf-like points in south Pannonia and in the western Balkans, so future investigation at the terrace open the possibilities for solving at least some of these questions.

Studying of these types of industries is essential also because they are generally associated with the Neanderthal populations (Allsworth-Jones 1990) and their local development as the basis for many hypotheses about the transition from Middle to Upper Palaeolithic (Zilhao 2009). Thus there are for example opinions that the process of transformation from the Levallois technology to the Upper Palaeolithic technologies of striking blades could be followed in these industries in the eastern Balkans (Tsanova 2012) and there are also opinions that acculturation of the Neanderthals took place in this phase in the western Balkans (Karavanić and Smith 1998). Hence any discovery which could shed more light on this problem would have great significance for comprehension of cultural changes and social interaction in that period.

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MIDDLE AND UPPER PALEOLITHIC IN THE BALKANS: CONTINUITIES AND DISCONTINUITIES OF HUMAN OCCUPATIONS

Tamara Dogandžić, Shannon McPherron and Dušan Mihailović

Abstract: One striking difference between the western and eastern European Paleolithic record is the marked lower site densities and less intensive evidence of human presence during Pleistocene in the east. The Balkans is a region characterized by diverse environments and landscapes, and it represents a crossroads of human population migration routes linking southwest Asia, eastern Europe and central Europe. It is, as well, considered a refugium for flora, fauna and hominins during glacial periods. Still though, we know little of human population history throughout the Pleistocene. While poor history of research is a possible underlying factor, increased investigations in the last decades resulted in advances in Paleolithic studies that offer the opportunity to investigate the character and intensity of human settlements. Varied intensity and patchiness of the occupation record can be evidence of demographic differences and population fluxes, specific spatial patterns, and continuities and gaps of human settlements possibly as a result of environmental and climatic factors. To better understand the history of human occupation of the Balkans in regard to these factors, it is therefore essential to have information on the spatial and chronological pattern of Paleolithic sites in the region. Both as a refugial 'core' area and a migration corridor, the Balkans may offer a crucial dataset for some of the major questions in Paleolithic research in a European context. One of the great contributions of new research and data is understanding population replacement during the Middle to Upper Paleolithic transition. Here, we will review the role of the Balkans in the Paleolithic and present some initial investigations aimed at understanding human population history in the Balkans.

Key words: Palaeolithic, Balkans, Aurignacian, Gravettian, Velika Morava

Introduction

Having a prominent geographical position at a crossroads between southwest Asia and western Europe, southeast Europe can be considered as one of the crucial areas in the study of population movements during the Pleistocene. Moreover, questions on human adaptations to climate change and factors underlying the variability in lithic industries on an interregional scale would greatly benefit from larger and better datasets from this area. The central Balkans, however, with the current state of research, continues to be an area with insufficient number of sites providing long, reliable and securely dated stratigraphic sequences. This lack of information on Paleolithic occupations is to some extent due to a less intensive research history. However, the question remains as to whether this scarcity of sites could also be attributed to other factors such as demographic differences between different regions in Europe during the Pleistocene or to erosional episodes that have removed evidence of human occupation. While some parts of eastern Europe are believed to lack sites as a result of geological factors, namely thick loess deposits that tend to bury locations of human occupation mainly of Lower Paleolithic chronology making them difficult to discover (Romanowska 2012; Iovita et al. 2013), this may not be the case for areas not covered in loess, or at least it has not been demonstrated.

Different spatial and temporal patterns of hominin presence and absence might be explained by the demographic history of the area. Location, timing and intensity of human occupations in a given region can result from events such as population extinction or withdrawal, preferences for settlement or existence of suitable migration routes. A pattern already observed in the Balkans is stronger evidence for both early and later Upper Paleolithic along the northern river valleys, while the central mountainous region potentially shows gaps in sequences (Mihailović et al. 2011). More intensive research, however, is needed for ruling out discontinuity scenarios. With the Balkans being a potential refugia for Neandertals or Last Glacial Maximum (LGM) populations, an area for migrations in and out of those core regions and a 'highway' for population movements east-west, the regional research objective focuses on reconstructing these temporal and spatial patterns of Pleistocene human occupations. It will then be possible to examine the continuity of Neandertal presence and persistence in the Balkans, modern human dispersal and settlements during initial migrations and later settling in the region. Here we will discuss geographical aspects of Paleolithic occupations of the central Balkans in reference to known Paleolithic record and main questions to be investigated in the current research. Moreover, results of a two year survey and test excavation in eastern Serbia designed to discover new stratified Middle and Upper Paleolithic sites will be presented. Investigations like this, designed as multidisciplinary research, will contribute to our understanding of the history of human occupations in the Balkans.

Middle and Upper Paleolithic in the Balkans

Specific geographical features of the Balkan peninsula

Geographically defined by its marine boundaries, the Adriatic, Ionnian and Black Seas at its western, southern and eastern limits, the Balkan's northern limits have been a matter of debate, depending on whether political or geographical boundaries are taken into account. The most common limits taken, and used here as well, are the rivers Drava, Sava and Danube (Reed et al. 2004). The Balkan peninsula is characterized by great diversity in topography and climate, though it is regarded as mainly a mountainous region. The three main geographic and climatic zones of the Balkans are the Mediterranean coastal area, the mountain chains of Dinarides, Balkan-Carpathian, Rhodopes, Pindus, and the northern lowlands that are part of the same environmental zone as the Low Danube and Black Sea lowlands (Furlan 1977). The main geographical feature of the peninsula are west-to-east transcending mountain ranges that divide the Mediterranean geographic and climatic region from the northern plains. Mountains of the central Balkans are, unlike in the Mediterranean zone, gently sloping towards the Pannonian plain opening to central and eastern Europe. This geographically transitional zone is characterized by major river valleys that act as migration routes for large herbivores and humans. It belongs to European environmental overlap zones, between northern and southern regions (Davies et al. 2003; Stewart 2005), characterized by greater ecological diversity.

Along with the Iberian and Apennine peninsulas, the Balkans is one of southern Europe's refugial regions where flora, fauna and probably human populations survived glacial periods (van Andel and Tzedakis 1996; Hewitt 2000; Tsedakis 2004; Weiss and Ferrand 2007; Dennell et al. 2011). Some authors emphasize that the Balkans is the main refugia since it is more open to the northern plains unlike Iberia or Apennines that are blocked from the neighboring regions by the Pyrenees and the Alps. This is consistent with the notion of the Balkans as a geographically transit zone (Hewitt 1999, 2000). The diverse geographical background of the Balkans probably could have represented both *cul-de-sac* and a gateway to Europe (Kozlowski 1992), rather than acting exclusively as one or another.

Middle and Upper Paleolithic occupation of the Balkans in a European context

Aside from a few well known sites, the Balkans still has a sparse Neandertal record. Given the large region of the peninsula and known Middle Paleolithic locations (Fig. 1, a), a number of sites with dense archeological records and larger chronological spans is still low. This raises the question of whether low density and intensity of Neandertal presence in this large territory is a reality or a bias produced by research history. How much of their presence should one expect given the geographic features of the Balkans? Within the large area that these hominins inhabited, core regions where an abundant archeological record with a continuous presence are demonstrated mainly in the southern parts, while northern regions show occupation discontinuities marked by absence of hominins during unfavorable climatic conditions (Stewart 2005; Finlayson 2008; Serangeli and Bolus 2008; Hublin and Roebroeks 2009; Roebroeks et al. 2011). Based on European Middle Paleolithic site patterns of the Last Glacial it seems probable that Neandertal communities were sparse during OIS4 and that the re-colonization of western Europe came from the east, following a probable Danube, Meine and Rhine route (van Andel et al. 2003) or out of refugia. The question arises as to whether the core refugial area of the Balkans is located in the southern coastal belt; then potential local extinctions could have been conceived in the mountainous part of the peninsula. Or, on the contrary, a continuous occupation characteristic for core regions should be expected in the central part of the Balkans as well. A near absence of securely dated sites from OIS 4 at this moment suggests the former is more accurate. On the other hand, Ne-

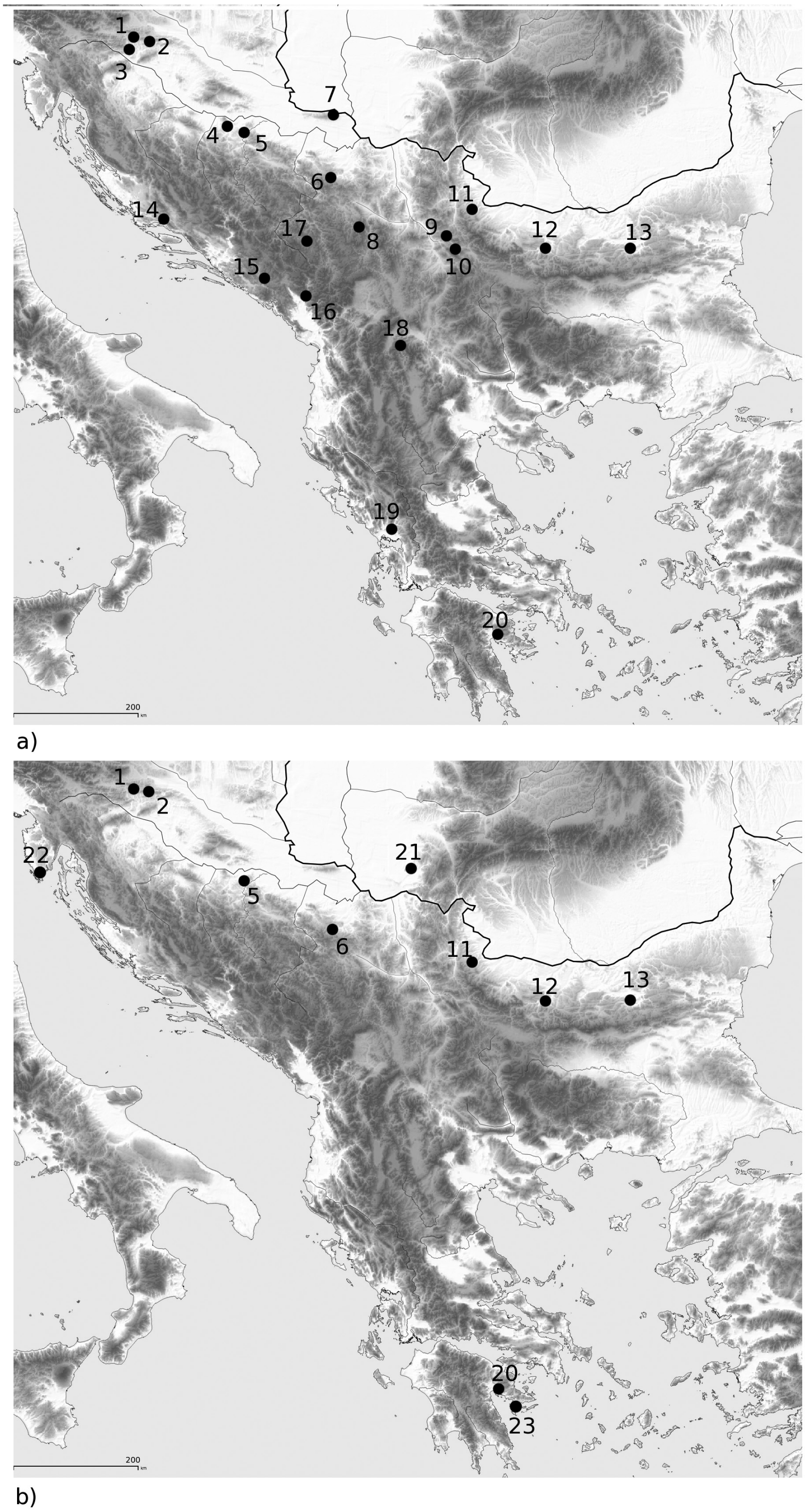


Figure 1. Distribution of main Middle (a) and Early Upper Paleolithic (b) sites in the Balkans: 1-Vindija, 2-Velika pećina, 3- Krapina, 4- Zobište, 5– Lonđa, 6- Šalitrena pećina, 7- Petrovaradin, 8– Hadži-Prodanova pećina, 9-Velika & Mala Balanica, 10- Pešturina, 11- Kozarnika, 12- Temnata Dupka, 13- Bacho Kiro, 14- Mujina pećina, 15- Crvena stijena, 16- Bioče, 17- Mališina stijena, 18- Golema pešt, 19- Asprochaliko, 20- Klisoura, 21– Crvenka At, 22- Šandalja, 23– Franchti.

andertal movements from Europe towards southwest Asia in OIS 6 or 5 as evidenced by the fossil record (Hublin 1998) or earlier Middle Pleistocene Balkan fossils' affinities with southwest Asia suggest that the Balkans had a transitional role between the east and the west (Dennell et al. 2011; Roksandic et al. 2011; Rink et al. 2013). Moreover, similarities in lithic industries also support links with southwest Asia (Kozlowski 1992; Mihailović et al. 2011; Rink et al. 2013) indicating that acquiring more datasets on the variation of Neandertal technological behavior is of special importance. Given the sparse record, only more extensive investigations can point to continuities or hiatuses in the Middle Paleolithic hominin record so as to reconstruct biogeographic patterns of Neandertals.

Other debated questions that await better information from the Balkans are how long did Neandertals persist in the area and what was the demographic picture that incoming modern human populations might have encountered in the first phases of their dispersal into Europe. The population replacement that happened during the change from Middle to Upper Paleolithic across Europe was rather mosaic in nature. Depending on the region it followed different scenarios of Neandertal persistence, timing of modern human arrival and possible interactions (Hublin and Bailey 2006). While the patterns of late Neandertal presence, the chronological and stratigraphic continuities and discontinuities between late Middle and the earliest Upper Paleolithic and their potential spatial segregation on a local level are still debated (Conard et al. 2006; Jöris et al. 2011; Pinhasi et al. 2011; Mallol et al. 2012; Wood et al. 2013; Moroni et al. 2013), it has been recently estimated that the overlap between the two populations on a continental scale lasted up to 5,000 years (Higham et al. 2014). According to these data, Mousterian ended by 41-39ka BP, though some regional variation in dates should be expected. The Campanian Ignimbrite (CI) eruption at 39ka BP and the resulting cold event known as Heinrich 4 is commonly used as a chronological marker and possibly a causal factor of Neandertal demise (Fitzsimmons et al. 2013). On the other hand, according to a climatic model by Müller et al. (2011), climatic deterioration during the Heinrich 5 event at 49 ka BP would have resulted in earlier reduction of Neandertal populations in eastern Europe.

Timing of the arrival of modern humans in Europe is thought to have happened earlier than the CI event, given the stratigraphic position of Protoaurignacian industries that lie below the tephra (Giacco et al. 2008; Banks et al. 2014). Aurignacian has long been used as a proxy for early modern human dispersal and the coexistence scenarios largely focused on Aurignacian chronology. Yet another, earlier movement of modern humans can be envisioned, marked by several Initial Upper Paleolithic industries from the Levant to the Balkans and central Europe (Emirian, Bachokirian, Bohunician), that documents probably the very first colonization of modern humans during the Greenland interstadial 13, as early as 48ka (Tostevin 2000; Svoboda 2005; Bar-Yosef 2006; Richter et al. 2008; Hoffecker 2009; Müller et al. 2011; Hublin 2012; Kuhn and Zwyns 2014). Although it needs to be confirmed with fossil evidence, such an early dispersal opens another possibility of chronological overlap and potential encounters of the local and incoming populations, earlier than previously considered (Hublin 2014).

As for the Balkans, the disappearance of Neandertals in the Mediterranean belt can be chronologically related to the CI eruption as evidenced at e.g. Crvena stijena (Morley and Woodward 2011) and by the fact that no Neandertal site in this region dated to after ca. 40 ka has been reliably confirmed (Rink et al. 2002). Aside from the later Aurignacian at Šandalja in Istria (Karavanić 2003), thus far, no transitional (Uluzzian) or Early Upper Paleolithic (Protoaurignacian or Early Aurignacian) has been identified in eastern Adriatic region, from southern Greece to northern Italy, i.e. between Klissoura and Fumane (Mihailović et al. 2011), that would evidence for the movements of their makers, currently assumed to be modern humans (Benazzi et al. 2011). Thereafter, it is sill difficult to follow the earliest appearance of modern humans in this part of the Mediterranean coast.

In the northern Balkans, along the corridor of the modern human expansion (Conard and Bolus 2003), timing of Neandertal demise is still not resolved. Recent AMS dates from Vindija's last Neandertals at ~32-33 ka (Higham et al. 2006), Šalitrena pećina 38 ka BP (Mihailović 2013) and ESR dates at Pešturina at 37,8+/- 2 ka, may point in that direction (Blackwell et al. 2014). Except for the much debated record of the alleged cultural contacts in Vindija (d'Errico et al. 1998; Janković et al., 2006), no data on potential cultural influences have been found. A few isolated Szeletian foliate points at few sites on the northern fringes of the Balkans represent the only transitional assemblage group. So far, only eastern Balkan sites show Initial Upper Palaeolithic assemblages at Bacho Kiro and Temnata Dupka, and the western side of the Balkan mountain chain still shows no evidence of these industries. Early Upper Paleolithic assemblages, i.e. Protoaurignacian and Early Aurignacian are known at a few sites, including Kozarnika (Tsanova and Bordes 2003; Teyssandier 2008; Tsanova 2008; Tsanova et al. 2012) and other sites scattered in the northern parts of the Balkans, in Banat (Mihailović 1992; Sitlivy et al. 2012), northern Serbia (Mihailović 2013), northern Bosnia and Croatia (Fig. 1b). In this context, chronostratigraphy of Protoaurignacian and Early Aurignacian, that seem to be divided by the CI event (Banks et al. 2014) and represent statigraphically successive stages in western Europe, are still unclear in southeastern Europe. It is difficult to reconcile the idea of them being separate migration waves with the contemporaneity of southern Protoaurignacian and central European Early Aurignacian as evidenced by radiometric dates (Higham et al. 2012). In addition, their difference may likewise reflect an adaptive shift (Banks et al. 2013). Relationship between the phases of Aurignacian in this part of Europe doesn't seem to conform the clear western European succession (Sytlivy et al 2012).

In sum, while within a time range between 45-40 ka BP in Europe, various Middle Palaeolithic entities, 'transitional' (e.g. Szeletian, Chatelperronian, Uluzzian) and Early Upper Palaeolithic assemblages are present, in the northern Balkans, a region where potentially late Neandertals and initial stage of modern human dispersal in Europe can be detected, the spatial-temporal mosaic of the two populations remains largely vague. It is, therefore, essential to acquire a good archaeological and chronological record to evaluate the potential coexistence of these populations and to reconstruct the regional replacement scenario. The idea of a Danube Corridor, whose role in populations migrations has been widely acknowledged (Kozłowski 1993; Conard and Bolus 2003, 2008), indicates the importance of river communications in migrations and can as well point to the significance of other river valleys in the Balkans. It still remains uncertain what the geography of first modern human settlements would have been and how large a territory those dispersals encompassed. Were other corridors, major ones such as Velika Morava, used as well by migrating populations? If yes, the geographical overlap with late surviving local populations is a possibility.

Similar issues of geography and continuities and discontinuities of human groups are present in the late Upper Paleolithic of the Balkans. Gravettian and Epigravettian sites are mainly found along the river corridors in the north and along the Adriatic, but not inland, even though the Balkans should have been a refugia for central European populations at the onset of the LGM (Kozlowski 2000; Mihailović 2007; Mihailovic and Mihailovic 2007). Here again, identifying withdrawal and abandonment of certain regions and their recolonization from refugial area remains an important factor in demographic histories (Montet-White 2000; Verpoorte 2004, 2009). New research that identified new sites in the inland of the peninsula from this period helps fill in the gaps of late Upper Palaeolithic presence (Mihailović and Mihailović 2006; Mihailović and Milošević 2012).

Paleolithic occupation in the central Balkans

Searching for human occupations and migrations routes

From a perspective of biogeography, factors such as environment, climate and topography influence choices of settlement and furthermore, persistence, withdrawal and migrations of humans in a given region. Although marked difference in site density across Paleolithic Europe is generally recognized to exist between the west and the east, a conspicuously high density of sites is actually found in three areas in Europe: the Dordogne and Vezere valleys of southwest France, Ardennes in Belgium and the Middle Danube basin, and are thought of as 'attractive' or preferred regions for human habitation (Davies et al. 2003). They show, furthermore, more or less continuous human presence. In geographical terms, all three areas have a few features in common: river valley topographies with adjacent lowland areas providing mosaic ecotones characterized by diverse resources. They are overlap zones between northern and southern European province (Stewart 2005), transitional zones from highlands to lowlands, showing the continuation of human presence that testify to their good strategic position. As said above, the Balkans' low hill areas at its northern borders, where mountains meet wide river valleys, are potentially areas suitable for continued habitation and colonization. Indeed, most of the stratified sites with evidence of Middle, Early and Late Upper Palaeolithic are positioned in this region. Moreover, these river valleys act as 'highways' linking the Balkans with eastern and western Europe. The wide valley of Velika Morava in central Serbia is part of this overlap zone (Fig. 2a). It is situated between two mountain ranges, Dinarid and Carpathian-Balkan geotectonic units, and flows north towards the Danube and Panonian lowland. While still further away from the Danube corridor, Velika Morava valley is a good example of a transitional zone from highlands to lowlands. As one of the largest river corridors in southeastern Europe, it represented a migration route for large herbivores in Pleistocene (Forsten and Dimitrijević 2003) and possibly humans. Southern parts of the valley are situated well into the inland of the peninsula and its mountainous regions. Furthermore, Serbia is a carst-rich region and its eastern part stands as one of the richest in carstic forms (Cvijić 1895; Petrović 1976) where around 460 caves are known (Jović 1997). All this said, this region has an immense potential for discovering stratified human habitation sites.

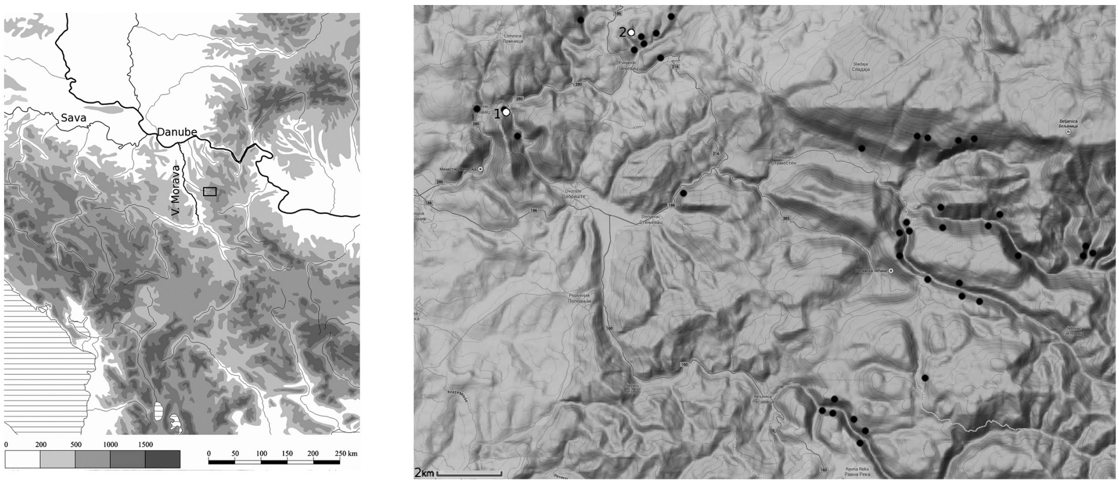
Considering the Balkans' role in the Paleolithic, a few research questions come forward. First, can we find continuity in occupation throughout the Middle and Upper Paleolithic that would testify to the refugial and strategic nature of the region. Identifying presence or hiatuses of hominins helps to reconstruct biogeographical processes of abandonment, continuous occupation, expansions and migrations. One of the major questions here is whether and how densely was the region populated at the time of the modern human arrival. As a region acting as a transit route since the Middle Pleistocene, can we identify migration corridors other than Danube in the Balkans? In the context of early modern human expansion at the beginning of Upper Paleolithic, the extent of the initial diffusion away from the north corridor acts as another factor in the context of interaction of late local and incoming populations. Potentially, in a diverse environment of the Balkans, there may have been settlement preference and differences in niche exploitations between the two populations or potentially topographic and geographic boundaries between the refugial and corridor regions as observed elsewhere (Finlayson 2004). The extent of initial phases of modern human dispersal beyond eastern Balkans, possibly marked by Initial Upper Paleolithic assemblages, still remains uncertain. Scant evidence of their presence may indicate rather brief occupations characteristic for 'pioneer' phases of colonization that may not significantly affect local populations (Davies 2007). This said, it needs to be determined which industries mark first migrations in southeastern Europe, what was the extent and nature of those expansion and settlements and at which point those became more residential that covered inner parts of the peninsula.

New data on the Paleolithic in Velika Morava valley

Directed toward investigating these questions, new research in central Serbia has been undertaken. Previous archaeological surveys and investigations that covered eastern Serbia (Gavela 1988; Đuričić 1990, 1996; Mihailović et al. 1997) have revealed only a few Paleolithic sites with very low artifact densities. A new campaign of survey for Paleolithic sites was organized along the valley of the Resava river, a right tributary of Velika Morava[1] (Fig. 2). The Resava river valley,

[1] Survey and excavation project has been organized in 2012 and 2013 in collaboration of Department of Archaeology, Faculty of Philosophy, Belgrade and Department of Human Evolution, Max Planck Instiue for Evolutionary Anthropology.

the longest right tributary of Velika Morava, and the limestone rich areas of the Beljanica mountain in the upper parts of its valley, have been investigated by geographers since early days (Cvijić 1895; Paunković 1953; Petrović 1976). The Resava valley is divided in two areas of quite different relief (Fig. 2). The mountainous region of upper Resava in the east, with vertical slopes of the Beljanica mountains and steep and deep canyons of the Resava and its tributaries Čemernica and Suvaja, is dominated by Jurassic and Cretaceous limestone units. To the west, towards Velika Morava, the valley is surrounded by gentle hill slopes of Jurassic and Tertiary limestone areas as well as Pliocene travertine deposits around Panjevac. Diverse landscapes of the valley offer an opportunity to investigate landscape context in different Paleolithic times.



a) b)

Figure 2. a) Valley of Velika Morava and location of area surveyed for Paleolithic sites b) position of recorded caves and shelters in the Resava valley and two sites with Paleolithic deposits, 1-Bukovac, 2-Orlovača.

Survey followed a strategy aimed at finding natural occupation sites in caves and shelters, following previous publications and records of known caves as well as geological context. 49 caves and shelters were recorded (Fig. 2). Potential archaeological sites were assessed based on sediments preserved, artifacts on the surface, location and accessibility. Overall, around 10 caves and shelters were considered sites with a potential for further archeological investigations. Topography of the site location clearly was affected by quite varied landscape features of the valley. Caves in the eastern part were in somewhat distinct setting, in the steep canyons located either in higher elevations and less accessible or almost at the river level. Probably due to erosional processes, rarely were their sedimentary terraces preserved. Still, a number of them had great archaeological potential. Some of the most promising caves have been found on the southern slopes of Beljanica mountain, at 700 m elevation. Those are Tunnel caves, consisting of two once connected caves, Velika cave and Bušna cave. They both have large surfaces, very thick sedimentary deposits and remains of prehistoric pottery and archaeological remain from Roman period on their surfaces. Western part of the valley area had lower number of caves and shelters. The majority of them were found in lowland travertine deposits around village Panjevac, previously not known nor surveyed by archaeologists.

After an initial season, of the identified prospective caves and rockshelters, four locations in the vicinity of Despotovac, in the western part of the valley, were chosen to be excavated. Two sites have not yielded Paleolithic strata, and in two caves, Bukovac and Orlovača, sediments with preserved Pleistocene deposits have been discovered. Bukovac cave is situated on the bank of the Resava river, at an elevation of 250 m, with the shelter part of the cave being 7 m in length and up to 6m wide, with a wide terrace that slopes down towards the river. Test excavations covering an area of 3 m² to a depth of ~80 cm revealed Pleistocene layers starting from the surface. All finds were piece-provenienced in a coordinate system with a total station. The upper layers (2a and 2b) contain lithic (n=70) and faunal (n=850) remains; of the lithic artifacts there is a high frequency of backed bladelets and a bone point (Fig. 3). The lower layer (3) contains traces of burning with the presence of charcoal, burnt bones and lithics. Archaeological finds are more numerous than in the upper layer (120 lithics and more than 2000 faunal remains), though relatively fewer retouched pieces were discovered with flaking by-products being more abundant. A preliminary observation finds affinities of upper layer artifacts with the Epigravettian and the lower ones with the Gravettian, though more data is needed for precise attributions.

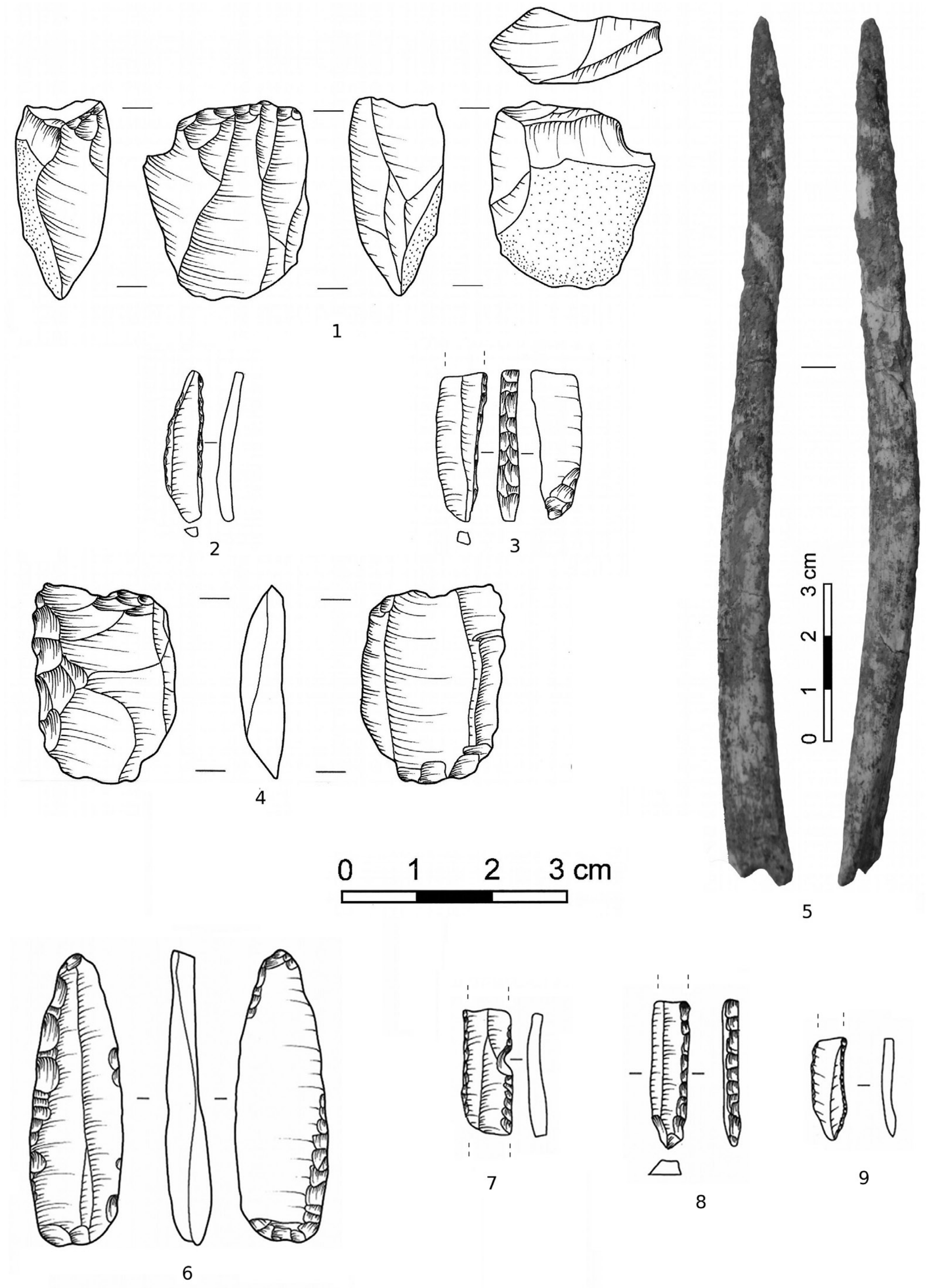


Figure 3. Artifacts from Bukovac upper (1-5) and lower (6-9) layers.

Around 5km northeast from Bukovac cave, in the village Panjevac, Orlovača cave has revealed Holocene and Pleistocene deposits. The site lies at 400 m asl, in Pliocene travertine deposits. In this 9x9 m cave, a test trench of 2x1 m was excavated up to 1m depth. A small assemblage from two Pleistocene layers revealed a core and backed bladelets in the upper layer (2) and layer 3 contained, among a few artifacts discovered, two endscrapers (one is a combined endscraper-point), a pointed blade and bladelets of Dufour type with alternate retouch, with the flat inverse retouch on the right edge and direct retouch on the left edge. While the latter are a strong indica-

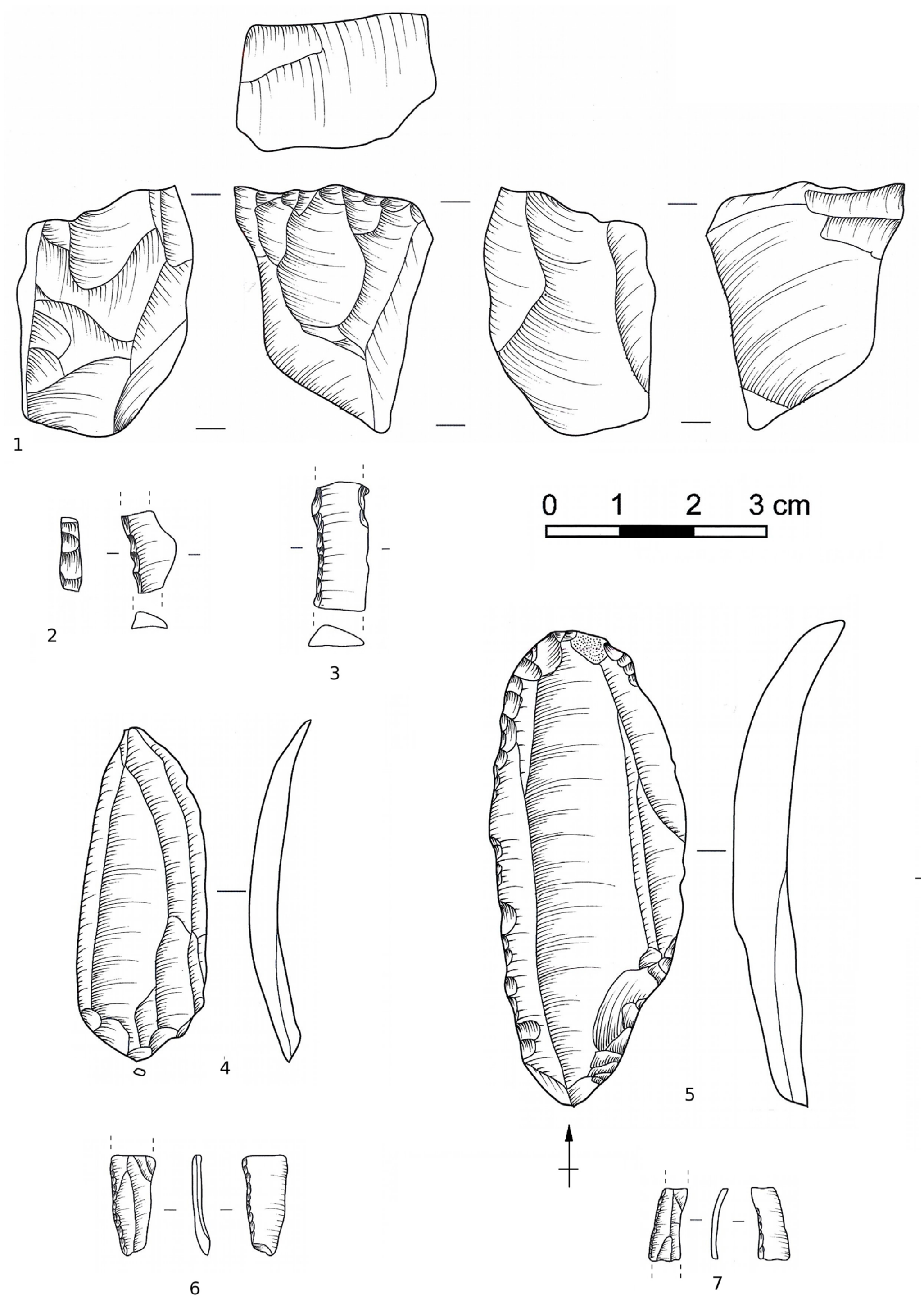


Figure 4. Artifacts from Orlovača upper (1-3) and lower (4-7) layers.

tion of Early Upper Paleolithic, the exact cultural attribution of this layer will only be possible with a larger lithic dataset and reliable chronological information. At both sites the current test excavation did not reach bedrock and it is almost certain that both contain older strata that, along with promising finds, suggest a great potential for stratified habitation sites with broader chronological spans.

Conclusions and perspectives

In our attempts to better understand the history of human occupation in the Balkans it seems essential to evaluate whether sparse evidence for human presence represents an empirical reality or a research bias. Any study of human occupation history based on site distribution cannot be reliable before insufficient investigation factor is ruled out. Results from this archaeological research, that identified new late and early Upper Paleolithic occupations, suggest that at least to some extent the lack of human occupations in the late Pleistocene can be attributed to less intensive investigations.

New data on late Upper Paleolithic industries that show evidence for occupations probably before and during the LGM will fill the gaps in the data from the central Balkans about continuities of habitation and adaptations during this time period. Until recently, the distribution of Gravettian sites in southeastern Europe showed a conspicuous gap from central Europe to Bulgaria, but with recent investigations it becomes more clear that discontinuity was a result of a lack of research and that these new data contribute to understanding migrations and adaptations during this time (Mihailović i Milošević 2012; Mihailović 2013).

Existence of small Dufour bladelets at Orlovača cave is consistent with Protoaurignacian and Early Aurignacian, though only larger dataset and additional information on the production systems will allow for further similarities with regional and western European context. A plausible indication of Early Upper Paleolithic settlement at Orlovača cave will offer an opportunity to better understand its chronology and the relationship between its variants. These data will likewise give insight into how large a territory the initial peopling of modern humans included. Moreover, it will be possible to unravel the nature and intensity of these first modern human settlements with further extensive excavations and interdisciplinary investigations. Finer chronological framing of these occupations not only will help build regional chronologies but also signal potential hiatuses in human occupations. Furthermore, planned geomorphological studies will elucidate continuities or reveal potential sedimentary gaps or erosional episodes at single site scale.

These newly discovered sites potentially cover a larger chronological range and will provide valuable information about Pleistocene settlements in the region. If this proves to be the case, such a diverse landscape of river valleys that cross-cut mountains of low to medium elevations and run to wide open valleys of the Morava and Danube can be thought of as favorable regions according to environment attractiveness, resource potential, or areas of likely migration routes. A potential for discovering several sites will help us better understand human settlement decision making that can be driven by resource distribution and landscape patterns. Therefore, subsistence reconstruction and landscape use strategies are a constitutive part of these studies and will provide data for investigating potential differences in exploited niches, topographical preferences or boundaries of distinct Paleolithic groups.

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THE SOUTHEAST SERBIA PALEOLITHIC PROJECT: AN INTERIM REPORT

Steven Kuhn, Dušan Mihailović and Vesna Dimitrijević

Abstract: The more facts accumulate about the dispersal of modern humans and the Upper Paleolithic across Europe, the more complicated scenarios abstracted from the evidence become. Diverse regional culture complexes and independent developmental trajectories suggest multiple dispersal events as well as varied patterns of interaction with indigenous hominins. Southeastern Europe, the geographic gateway between Anatolia and Europe, shows multiple early Upper Paleolithic sequences, with evidence for both local developments and external influences. Southeastern Serbia presents an opportunity to study the interactions between populations and cultures at this pivotal interval of time. In 2011 we initiated the Southeast Serbia Paleolithic project, beginning with a survey of cave sites followed by three seasons of test excavation in seven caves. Findings to date include four Middle Paleolithic and three Upper Paleolithic components. Middle Paleolithic layers show a significant presence of bears, hyenas, and other large carnivores. Upper Paleolithic layers include Gravettian and possibly Aurignacian components.

Key words: Paleolithic, Serbia, Mousterian, Aurignacian, Gravettian

Introduction

Investigations of the dispersal of *Homo sapiens* into Eurasia, encouraged in part by findings from genetics, have multiplied in the last two decades. The amount of archaeological information pertaining to the dispersal of modern humans and the Upper Paleolithic has grown at a similar pace. This welcome expansion of knowledge is accompanied, inevitably, by increasingly complex scenarios for demic expansions and cultural dispersals. At one time a single scenario sufficed to account for available evidence. In this model, the arrival of the early Aurignacian marked the first entry of *Homo sapiens* into Europe from the East, and the signaled beginning of a rapid decline of indigenous Neanderthals. Inevitably, as knowledge has accumulated the story has become more complicated than this. Divergent trajectories of regional cultural development attest to multiple dispersal events as well as varied patterns of interaction with indigenous hominins. Southeastern Europe, one potential geographic gateway between Europe and the Levant (and ultimately Africa) (Kozlowski 1992) is no exception. There are at least two rather different early Upper Paleolithic sequences in the region, one characterizing Bulgaria and the southern Balkans and one characterizing the Danube corridor.

The Middle Danube corridor (Austria, Moravia) seems to witness a set of cultural developments consistent in many ways with older, simpler scenarios. The early Upper Paleolithic record of this area begins with The Bohunician and Szeletian, two rather different complexes of uncertain origin and authorship (Kozlowski 2000; Nigst 2012: 23,28; Nigst and Haesaerts 2012) . Moreover, the Bohunician currently seems to be confined to Moravia. Overall, however the EUP record in the Danube basin is dominated by Aurignacian. Indeed some of the earliest dated Aurignacian deposits in Europe come from the Danube corridor and adjacent regions (Nigst and Haesaerts 2012; Teyssandier et al. 2006; cf. Banks et al. 2013a,b).

In Bulgaria, the early Upper Paleolithic sequence begins with the Initial Upper Paleolithic/ Bachokirian (IUP), which resembles the Bohunician (Kozlowski 2000; Tsanova 2008). Due in part to a scarcity of skeletal evidence the authorship of this complex remains unclear: some researchers argue that it was the work of modern humans, whereas others believe that indigenous Neanderthals could well have produced it. In the sequences at Bacho Kiro and Temnata Dupka the IUP is followed by the classic early Aurignacian (Kozlowski 2000; Kozlowski et al. 1982). Kozarnika, the site closest to our research area, presents a somewhat different sequence. The earliest Upper Paleolithic, from the base of layer 6/7, is poorly characterized. The succeeding industry (the Kozarnikan) contains an abundance of straight retouched bladelets (Guadelli et al. 2005; Sirakov et al. 2007; Tsanova 2008): this assemblage has been compared to both the western European proto-Aurignacian and the Levantine Ahmarian complexes, and in fact could represent a bridge between them (Tsanova et al. 2012). Although it is not the topic of this paper, we note that cultural developments in Greece, or at least in the Peloponnese, seem to take a quite different trajectory (Koumouzelis et al. 2001).

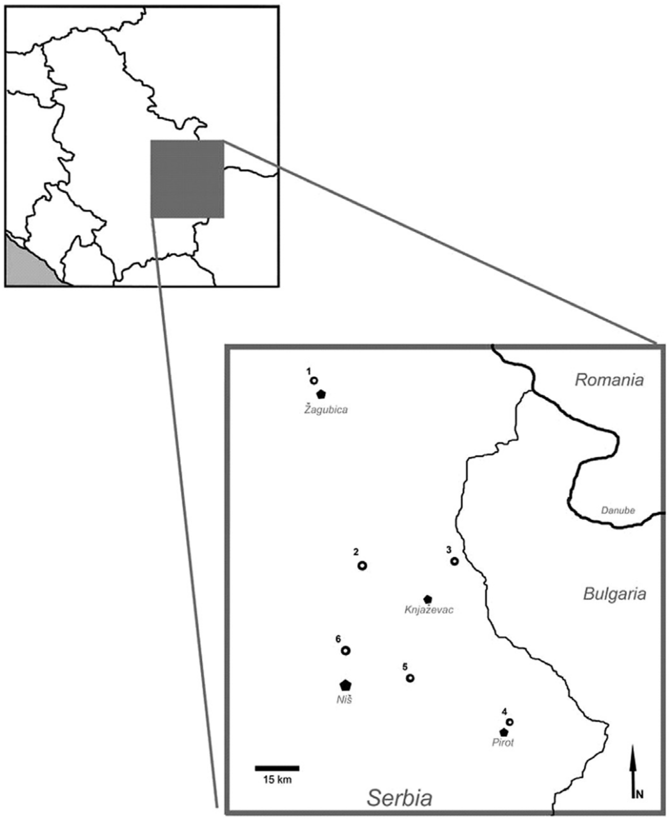

Figure 1. Regional map showing location of sites and nearby cities. 1, Velika Pećina; 2, Milušinačka Pećina; 3, Selaćka 3; 4, Kozjia Pećina; 5, Donja Pećina; 6, Meča Dupka.

The divergent cultural evolutionary trajectories in the southern Balkans and the middle Danube corridor certainly reflect somewhat different demographic and cultural dynamics. Southeastern Serbia, situated at the intersection between these two provinces, is potentially a laboratory for understanding the relationships between the Danube Basin and the southern Balkans, to see how indigenous and intrusive cultures and populations might have interacted. The Morava river valley which runs through the area also represents the best route of movement from south to north through the larger region, making it more likely that hominin populations might have passed into and through the area at different times. Interestingly, however, the archaeological record to date provides little evidence for an early Upper Paleolithic presence. Until now, Upper Paleolithic deposits predating the Gravettian were limited to a small, non-diagnostic dated assemblage from Baranica (Mihailović et al. 2011). Deep sequences from the thoroughly investigated complex of sites around Niš (Velika and Mala Balanica, Pešturina) contain very early Middle Paleolithic, later MP, and then Gravettian: Aurignacian, IUP or other early Upper Paleolithic assemblages are lacking (Mihailović 2008; Mihailović and Milošević 2012).

Several alternative hypotheses might explain the scarcity of early UP deposits in southeastern Serbia:

1. Robust Neanderthal populations persisted in southeast Serbia until relatively late, preventing the influx of early modern human populations;
2. Hominin populations of all sorts were sparse or absent during late MIS 3, especially from H5 through H4. The late Pleistocene landscapes might have been dominated by carnivores, which have left a strong signature in excavated archaeological sites;
3. There was a significant EUP presence in the area but the very limited amount of systematic research to date has not yet revealed it.

It was with these hypotheses in mind – especially the third – that we initiated the Southeast Serbia Paleolithic project. It began in 2011 with survey of caves around the municipalities of Knjaževac, Niš and Pirot. Research continued in 2012-2014 with test excavations in several caves. To date we have opened test trenches, or enlarged existing trenches, in 10 cave sites. Six of the sites have yielded evidence of Paleolithic human presence, ranging from isolated artifacts to rich assemblages. Two proved not to contain Pleistocene deposits: in one case the site had no substantial archaeological layers (Kožuvarska glama), whereas in the other the deposits all dated to the middle-late Holocene (Petrlaška pećina 2). The final site, which possesses the deepest cultural deposits of all the sites tested, may yet prove to have Pleistocene deposits. However these would be buried beneath very thick Holocene cultural layers which must be excavated carefully. In the following sections we will briefly review results from the six sites yielding evidence for Paleolithic human presence.

The Paleolithic Sites

Velika pećina (Fig. 1. n. 1) is situated in the narrow canyon of the Tisnica and Crna reka, northwest of Žagubica. The shallow cave or deep rockshelter has an open plan and a broad, high entrance (Fig. 2). The artificial terrace in front of the cave may have been created during road construction activities. The stratigraphic sequence consists of three main geological units, each of which we divided into several sub-layers. As in other sites, the uppermost deposits (layer 1) consist of dark, mottled organic-rich sediments, containing a few Paleolithic finds alongside prehistoric pottery and more recent artifacts. Layer 2 consists of clay rich sediments, varying both horizontally and vertically from yellow to red to nearly purple in color. Layer 2 contains exclusively Pleistocene fauna and artifacts. Layer 3 is also rich in clay but contains a much larger component of sand and fine gravel than layer 2. The excavations reached bedrock in part of the trench. However, there appears to be a step or ledge in the bedrock closer to the entrance, so that the deposits could extend deeper.

Figure 2. Velika Pećina.

The faunal assemblage is characterized by the dominance of small animal remains. These include range of birds and rodents, hare, as well as comparativly small carnivores, like weasel and red fox. Bones of large mammals (*Bos/Bison, Capra ibex, Cervus elaphus*) are rare and confined mostly to layer 3.

Paleolithic artifacts were present throughout the entire sequence at Velika pećina although their frequencies vary. All appear to be attributable to the Upper Paleolithic, the Epigravettian and Gravettian in specific. There is an especially dense concentration of artifacts and bones associated with what appeared to be a hearth feature in layer 3 just above bedrock in square L 19. Artifacts in this concentration include a large, symmetrical pointed retouched blade, several backed bladelets and at least two gravettes. Some large flakes and refitting pieces indicate *in situ* artifact production activities. The trench only captured a small part of this feature and associated concentration and we discontinued excavation once the richness of the deposit was evident. The next phase of excavation at Velika pećina will involve more careful excavation of layer 3 over a larger area.

A review of the finds from the entire sequence suggests that there may be more than one cultural component within layers 2 and 3. The assemblage associated with the hearth feature in L 19 contains mainly blades and large, thick, straight bladelets, suggesting that it belongs to the Gravettian (Fig. 3). There are more small retouched bladelets in overlying layers. Understanding whether these components are distinct, and whether they differ temporally or functionally, must await more extensive investigation of the site.

Milušinačka pećina **(**Figure 1, n. 2) is located northwest of Sokobanja, several km from the town of Milušinac. The cave is a moderately sized, low-roofed chamber with at least three entrances and some small side chambers. We collected a probable Middle Paleolithic flake from the surface when we first visited the cave in 2011. Subsequent excavations revealed that the cave contains a sequence of sedimentary infilling 2.5 m deep. Paleolithic artifacts are not common: only 12 lithic specimens were recovered from two test trenches, all coming from the uppermost

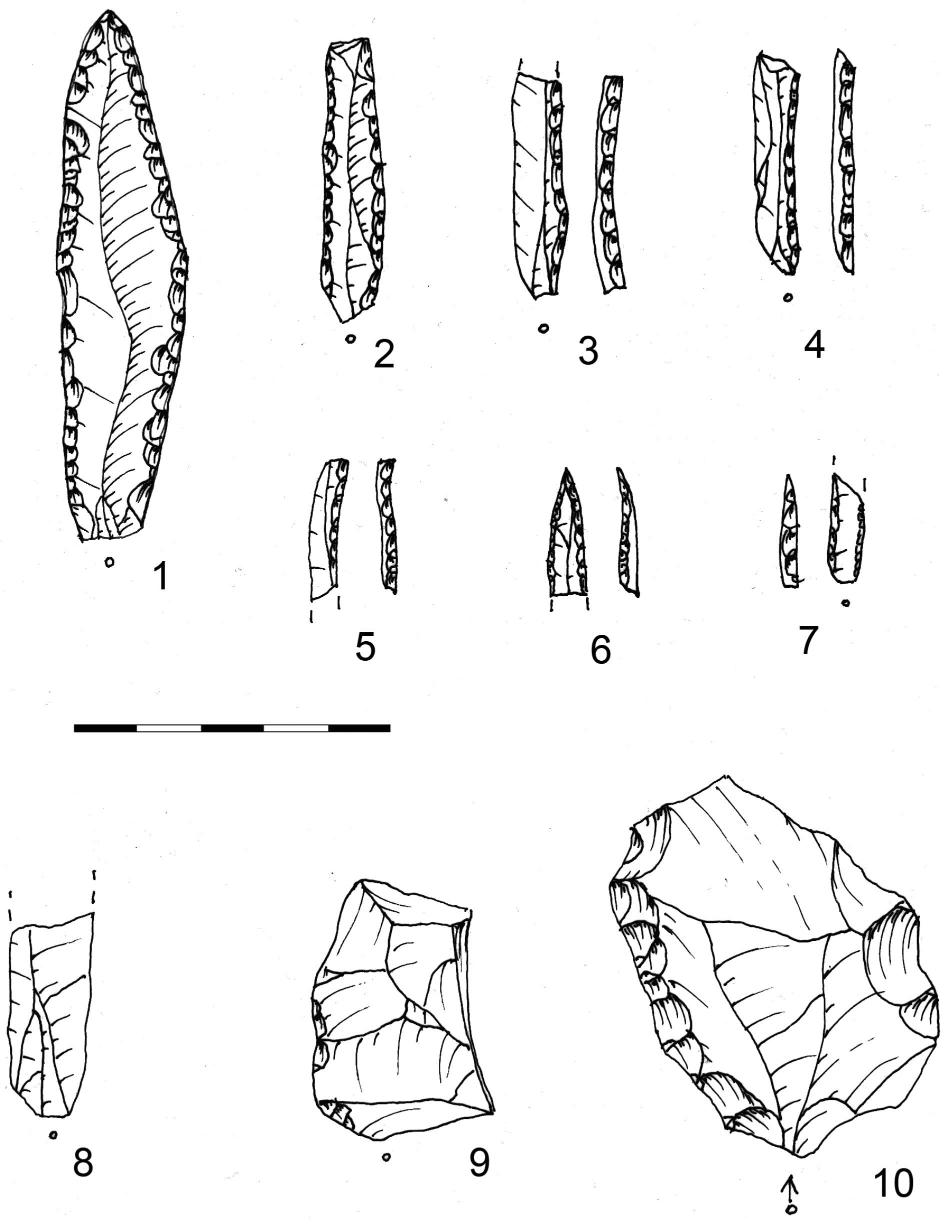

Figure 3. Stone artifacts from Velika pećina (1-7) and Milušinačka pećina (8-10).

meter of the sequence. The majority of the artifacts, including a large scraper/denticulate and a denticulate made on a *débordant* flake, pertain to the Middle Paleolithic (Fig. 3). A small, narrow flint bladelet from the surface layer may be evidence of an ephemeral Upper Paleolithic occupation as well.

For most of its history Milušinačka Pećina was used as a den by cave bears. Bear bones constitute the great majority of faunal remain and are found throughout the sequence. The abundance of bear remains and the presence of both old and very young individuals are consistent with hibernation deaths. Based on the sizes of the bones the species represented is the large, late Pleistocene form, *Ursus spaelaeus.* Other faunal remains from the site include *Canis lupus, Vulpes vulpes, Crocuta spelaea, Equus ferus, Cervus elaphus, Capra ibex, Bos/Bison*. Few fragmented teeth indicate the presence of a rhino. It appears that the most common occupants of the cave were bears, and that human presence during the Middle Paleolithic was limited to sporadic and brief occupations.

Figure 4. Selačka pećina 3.

Selačka 3 (Figure 1, n. 3) is situated NE of the city of Knjaževac, in the Selaćka valley. As it appears today the cave combines two narrow enclosed chambers with a somewhat more extensive rockshelter in the front: however the cave's morphology may have changed since the Pleistocene occupations (Fig. 4). The stratigraphy was divided into three major layers (1-3) with a series of sublayers within each. Layer 1 consists of dark, organic Holocene sediments containing artifacts dating from the Paleolithic to the modern era. Large amounts of what appeared to be iron slag were recovered during sieving of these deposits, indicating that the front of the cave may have housed a forge or even a smelting facility at some point. Layer 2 consists of reddish brown clay-rich sediment. It is extensively disturbed by pits and animal burrows. The fauna includes a mixture of domestic animals and wild species. In addition to historic and prehistoric ceramics, two Paleolithic artifacts were collected from layer 2. One is a basal fragment of a small, straight bladelet with fine inverse retouch on one margin. The other is a complete bladelet with a distinctly twisted profile. These are not absolutely culturally diagnostic but they do fall within the range of variation of Aurignacian *lamelles Dufour*.

Layer 3 at Selaćka 3 is clearly a Pleistocene deposit. It consists of yellowish sandy clay, gravelly in places. In most of the excavation trench layer 3 existed as mainly as infill to cracks and crevices in bedrock: consequently we did not excavate a large volume of sediment. A total of 17 artifacts were recovered from geological layer 3 (Fig. 6). They include two very small (ca. 30 mm in diameter) centripetally worked cores. Both have many typical Levallois features but do not possess classic Levallois morphology. Retouched tools include two sidescrapers, two denticulated pieces and several fragments of retouched pieces: flakes and retouched tools are also small, 25-40 mm in maximum dimension. Several of the flakes and tool blanks show dorsal scar patterns indicative of centripetal core exploitation. The raw materials are remarkably diverse for such a small assemblage, including quartz, several varieties of flint, and limestone. The small faunal assemblage (only ten identifiable specimens) include *Equus ferus*, *Capra ibex* and *Rupicapra rupicapra*.

Layer 3 at Selačka 3 clearly dates to the Middle Paleolithic. The small sizes of the artifacts dominance of centripetal/Levallois production suggest that it could be a fairly recent Middle Paleolithic (late MIS 4 or MIS 3). The high frequency of modified pieces (tools and cores) and the diversity of raw materials further indicate that the assemblage could have accumulated as a result of short-term visits to the cave. The findings from layer 2 are more ambiguous. However, the presence of two small bladelets, one twisted and one inversely retouched, does suggest that the site possesses an Upper Paleolithic component, perhaps even an early one. The goals of future research at the site will be to locate larger volumes of undisturbed sediments within the cave, especially pertaining to layer 2.

Kozja pećina (Figure 1, n. 4) is situated on the wall of a narrow valley a short distance northeast of Pirot. The small opening is about 30 meters above the valley bottom. The cave takes the form of a narrow tunnel 2-3 m wide, 8 m wide and 2 m tall In the back it opens into a larger, open roughly chamber 8 m across. A single test trench 2.5 by 1m in size was excavated in the narrow part of the cave just before it opens out into the larger cavity.

The stratigraphic sequence at Kozja Pećina is approximately 1.5 m deep (Fig. 5). Beneath the disturbed surface layer (1) is a layer of mottled brown silt with abundant angular limestone fragments (Layer 2). Layer 3 is a more homogeneous brown to yellowish-brown silt. Layer 4 at the bottom of the sequence is a homogeneous, red silty clay. In layers 2-4 limestone fragments within the sediment are extremely altered by chemical processes, in some cases almost completely dissolved.

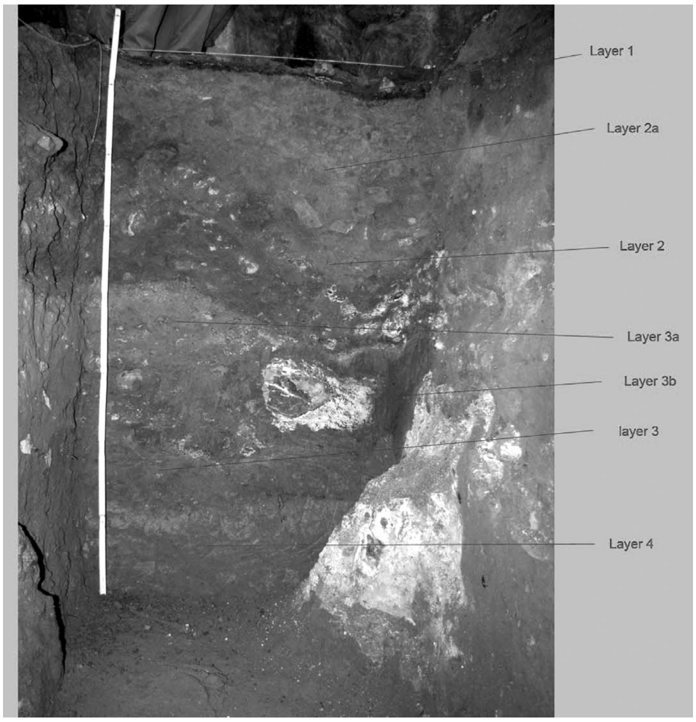

Figure 5. Kozja pećina: N20-N21 profile.

Kozja Pećina yielded a very large assemblage of vertebrate remains, although many of the bones are in poor condition as a consequence of post-depositional diagenetic alteration. Large bone fragments and partially intact specimens were found *in situ*, but many were so thoroughly de-mineralized that it was almost impossible to remove them whole. Most bones came from layers 2 and 3, but some bones were found in all layers. The faunal assemblage is moderately diverse. Common ungulate taxa include both large cabaline equids and *Equus hydruntinus*, *Bos/Bison*, *Cervus elaphus* and *Rupicapra rupicapra.* Small animals include *Lepus* and range of birds, rodents and bats. Often the remains are too fragmentary or too badly damaged to assign to a particular species or even genus. The most abundant carnivore is *Crocuta spaelea*, but bear (*Ursus* sp.) and *Vulpes vulpes* are also present. Although some bones bear gnawing traces, there are no bones severely damaged in a manner characteristic for hyaenas. The fragmentation of bones is mostly due to longitudinal cracking caused by physical-chemical agents operating in the depositional environment, but we do not exclude the possibility that primarily splitting of bones was of biogenic (carnivores or anthropogenic) origin. The small sizes of the bears and the large sizes of caballine equids could indicate a later Middle Pleistocene age. However, Upper Pleistocene deposits in southern Serbia also sometimes contain large horses, and it is possible that the bears remains are attributable to *U. arctos* rather than *U. deningeri.*

Evidence for human presence is limited to a single quartz flake recovered from layer 3, in close association with the animal bones. The raw material and the technological features of the artifact indicate that it dates to the Middle Paleolithic. Given its narrow entrance and situation high on the valley wall it is not surprising that carnivores found it more attractive than humans. However, with proper excavation the site has the potential to provide a large late Middle or Upper Pleistocene fauna. Moreover, experience from other sites in the Balkans (e.g., Zilhão et al. 2007) shows that such carnivore accumulations often contain hominin remains.

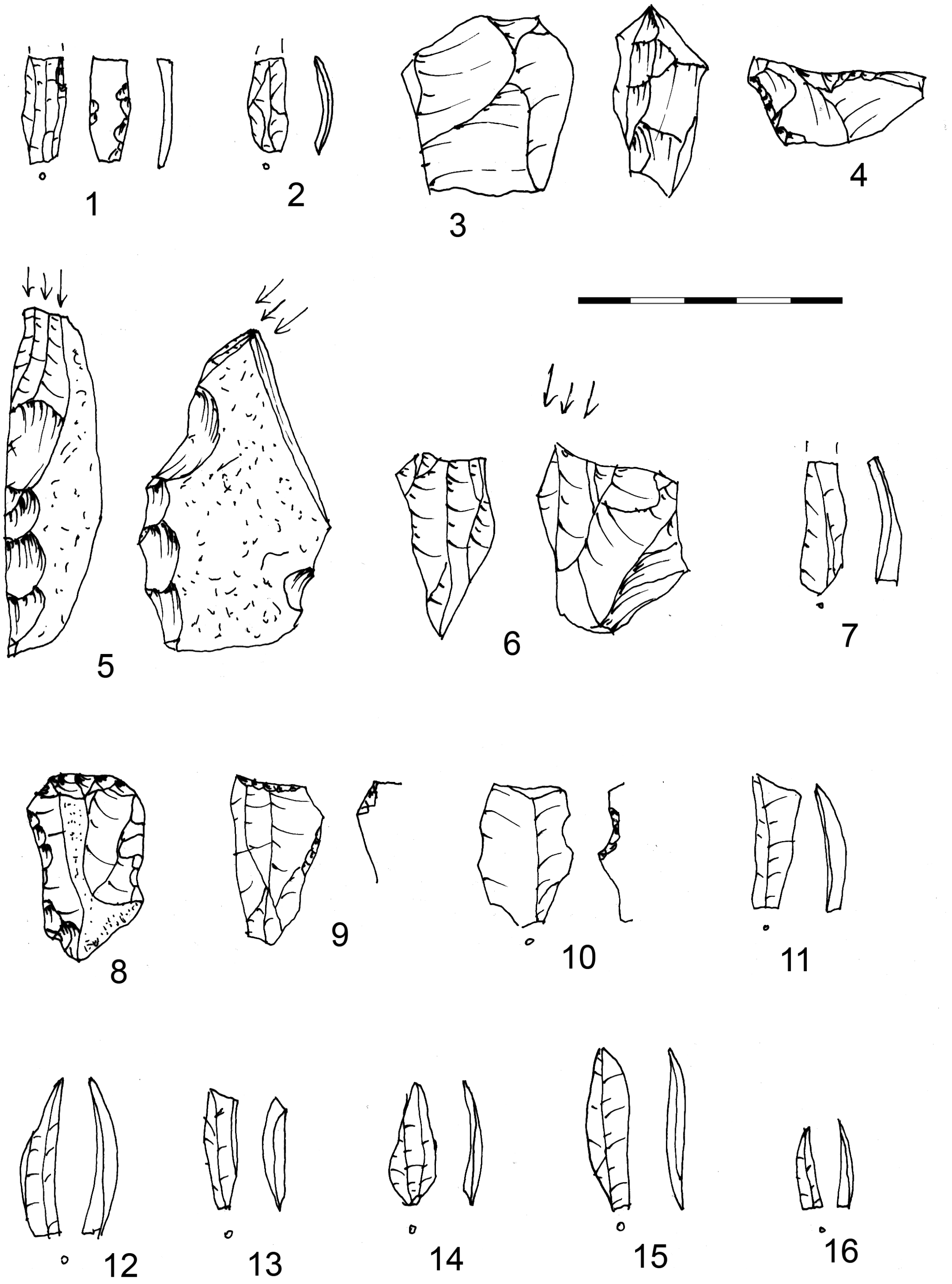

Figure 6. Stone artifacts from Selačka pećina 3 (1-5) and Donja pećina (6-15).

Donja pećina (Figure 1, n. 5) is a large, deep, multi-chambered cave situated on the north wall of the Sićevo Gorge between Sićevo and Gradište. A shallow rockshelter extends some 15 m from the entrance along the cliff to the east of the main opening. We excavated four test trenches at Donja pećina, one inside the cave and three in front. The majority of cultural finds came from trench n. 1, just east of the cave opening and in front of the rockshelter.

The uppermost layer (1) in trench n. 1 consists of dark loamy sediment rich in organics, and containing both recent and prehistoric pottery. The underlying layer (2) is yellowish silty clay with varying amounts of rock and gravel. It becomes increasingly gray with depth. In places pits were excavated into layer 2 and infilled with sediment from layer 1, but these are clearly visible due to differences in the colors and textures of the two layers.

Small numbers of flint flakes and blades were collected through most of layer 2. However, there is a very dense concentration of material in the south half of the trench near the middle of layer 2. Large roof-fall blocks separate the trench into two zones. Between the rocks and the rockhelter finds were relatively sparse: most of the material came from outside (south of) the large blocks.

The Donja Pećina assemblage is regionally unique (Fig. 6). The most common artifacts are small, narrow (< 5 mm) bladelets with distinctly twisted profiles. More than half of the 43 complete or near-complete bladelets are twisted, whereas only about one in four blades (> 10 mm wide) shows a twisted profile. Another important group of artifacts consists of five small *burin busquée* or cores for twisted bladelets. In addition there are a number of flakes typically produced from the maintenance of these cores. Not one of the bladelets is retouched. Retouched tools are confined to one small endscraper, an endscraper/bec, and a truncated blade. Faunal remains were wither not preserved or were seldom deposited in the area of trench 1, as only a few bone fragments were recovered. Although no thermal features were encountered charcoal was abundant in layer 2.

Donja Pećina appears to possess a single cultural component, attributable to the Upper Paleolithic. There is no obvious comparator in the southern Balkans. However, due to the abundance of twisted bladelets and carenated burin/cores it most resembles late Aurignacian assemblage from Alberndorf I in Austria (Steguweit 2010). The composition of the assemblage, with many small cores and unmodified bladelets, also points to a specialized occupation, perhaps a place where composite weapons were produced or maintained. Expanded excavations in the area of the artifact concentration as well as within the rockshelter may yet reveal other components.

Meča Dupka (Figure 1, n. 6) is part of an extensive karstic system a few km from the town of Cerje (Niš). Other larger caves nearby are protected as part of a nature park. The cave consist of a large, open chamber 16 x 7 m, with smaller side chambers. In 2014 we excavated two test trenches, each four m square,on top of looters' pits near the center-line of the cave.

The stratigraphy of Meča Dupka is rather difficult to resolve due to recent disturbance as well as multiple sources of sediment input during the Pleistocene. Underneath the typical dark, organic Holocene layer are equally typical red and yellow clay-rich Pleistocene sediments (layer 2). Numerous pits had been dug into the Pleistocene layers during the Holocene but these are easily defined. The Pleistocene layers vary in color, texture and amounts of sand and limestone debris, but the variants are all highly localized, and widespread sub-layers could not be defined with confidence. In places the sediments also contain small (3-5 cm) rounded pebbles of limestone as well as allochthonous rocks, suggesting that some of the sediments are fluvial in origin.

Both artifacts and faunal remains were recovered from Meča Dupka. The collection of 18 artifacts includes a double scraper on Levallois flake, another sidescraper on a *debordant* flake, a denticulate and a large retouched blade or point. All of the diagnostic pieces appear to pertain to the Mousterian. A single small bladelet could indicate a later occupation as well although it could also be an unintentional byproduct of Mousterian flaking. Some flint and quartz artifacts show evidence of water transport whereas others are very fresh, another indication that there are multiple sources of sediment at Meča Dupka. Another interesting find is a large (15 cm long) heavy cobble of volcanic stone. This specimen, which has clearly been transported from a nearby stream bed, exhibits clear signs of battering on both ends. Faunal remains include bones of large ungulates including *Bos/Bison* and *Cervus elaphus.* Importantly, carnivore remains are rare or absent.

From the limited evidence currently available Meča Dupka contains at least one Middle Paleolithic occupation and very limited evidence for carnivore involvement. The stratigraphy is still not resolved, however. It is possible that water flowing periodically through the central part of the cave where test trenches were located has obliterated traces of cultural stratigraphy. If so, the sediments closer to the walls of the cave may show stratigraphic distinctions more clearly.

Conclusions

From the initial results it appears that additional investigations in southeast Serbian sites have the potential to help clarify the picture of late Pleistocene dispersals into southern Europe. More than half of the sites tested contain at least some traces of Paleolithic occupation, and techno-typological observations indicate that the area was occupied in the Middle and early Upper Paleolithic. The potential presence of late Aurignacian is especially significant as this would be the first evidence of this particular culture complex in Serbia south of Carpathian range. It is interesting that the sites excavated show at most one, perhaps two substantial occupation levels, and that there are only ephemeral traces of human presence in two of them. In fact, there are no long and rich occupational sequences post-dating the early Middle Paleolithic in southern Serbia. As in other sites in surrounding regions, non-human carnivores also played a substantial, even dominant role in the accumulation of faunal remains in many sites. The seeming absence of long sequences, the large number of ephemeral occupations, and the abundance of carnivore-accumulated faunas, ass suggest that hominin populations were not very dense on the landscape in most of the study area during the late Pleistocene and that there was much discontinuity in settlement.

Although the ecological factors behind the sparse Middle and Upper Paleolithic occupation of southeastern Serbia remain unclear, they certainly merit additional investigation. For obvious reasons we know a great deal about parts of Eurasia where hominin populations were largest and where occupations were most continuous (e.g., southwest France, northern Spain, the coastal Levant). Regions with more discontinuous occupation, such as southeast Serbia, provide fewer data and consequently have so far contributed less to our understanding of late Pleistocene human ecology. On the other hand such regions have the potential to reveal a completely different dimension of the behavior of Neanderthals and early modern humans than are known from more richly-documented areas.

Acknowledgements
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INVESTIGATIONS OF MIDDLE AND UPPER PALAEOLITHIC IN THE NIŠ BASIN[1]

Dušan Mihailović

Abstract: In the last ten years investigations of the Palaeolithic in the Niš basin were focused on the excavations at Velika and Mala Balanica in the Sićevo gorge and Pešturina cave in the Jelašnica village. It has been concluded, according to the dating and analyses of microfauna, that these three sites cover a chronological span of almost half a million years and that, *ipso facto*, they offer exceptional possibilities for studying environmental, cultural and even evolutionary changes in the Middle and Upper Pleistocene. In this article the remains from the mentioned sites are examined within a wider regional framework and within the context of different explanations of technological changes and population migrations in the transitional periods.

Keywords: Balanica, Pešturina, Palaeolithic, Balkans, Mousterian, Charentian

Introduction

Investigations of the Palaeolithic in southeast Europe have been hitherto taking place in the Sava and the Danube valley and in the Adriatic coastal region, so central areas of the Balkans have remained generally unexplored. Only a few sites have been excavated – Bukovac in the Gorski Kotar region (Malez 1979), Pećina pod Lipom in Bosnia and Herzegovina (Kujundžić-Vejzagić 1991), Mališina and Medena Stijena in Montenegro (Radovanović 1986; Mihailović 1996) and Smolućka and Hadži Prodanova cave in southwestern Serbia (Kaluđerović 1985; Mihailović and Mihailović 2006), while in the Rodopes excavations have been conducted only in the cave Chuchura (Ivanova 1994). Nevertheless, this situation has started to change in recent years – investigations have been resumed in Bukovac, detailed site surveying has been undertaken in the region of northwestern Montenegro and investigations and test trenching have also started in Bulgaria. But the greatest shift has happened in Serbia. Many rich and multi-layered Palaeolithic sites have been investigated in the river basins of Timok, Morava and Nišava. Thus conditions have been created for initial comprehension of technological and economic changes in the Middle and Upper Palaeolithic in the central regions of the Balkan Peninsula.

History of Investigations

Investigations of the caves in eastern Serbia started with Feliks Hofman in the second half of the 19th century (Hofman 1882). After that Đoko Jovanović and Jovan Cvijić continued surveying and even carried out test trenching in some of the caves. Đ. Jovanović and J. Cvijić discovered a flint blade together with remains of Pleistocene fauna in Prekonoška cave in 1891 (Cvijić 1891), while Đ. Jovanović also found chipped stone artifacts in one cave in the Jelašnica gorge (Jovanović 1893). After that investigations of the Palaeolithic in eastern Serbia were abandoned, so in the first half of the 20th century caves have been visited only by geographers and biologists (Petrović 1976).

The interest has been restored only in the mid 1970s when in 1975 B. Gavela published site surveying of caves in the Kučaj region – in the area of Strmosten and Resava mining basin

[1] This paper was presented at XIX Meeting and Annual Session of Serbian Archaeological Society in Belgrade, on May 30-31 of 2007.

(Bogdanović and Sladić 1975). Site surveying and test trenching had been continued in 1980s by Z. Kaluđerović and Lj. Đuričić. On that occasion scarce Palaeolithic artifacts were found in the caves Pećurski Kamen, Markova pećina and Sokolska rock- shelter, while about ten artifacts from the Middle, Early Upper and Late Upper Palaeolithic have been discovered in the Baranica cave investigated in the 1990s (Mihailović et al. 1997). All this was insufficient to draw any definite conclusions about the settling of this area of the Balkans in the Palaeolithic period.

The turning point happened in the beginning of the 21st century when site surveying was conducted along the line of the Niš–Dimitrovgrad motorway. During the surveying around ten caves have been registered in the Nišava basin for which it has been assumed that they could possibly contain Palaeolithic finds and in the profile of one of them (Velika Balanica) Palaeolithic artifacts were discovered (Fig. 1). It soon turned out that this cave is rich and multilayered Middle Palaeolithic site.

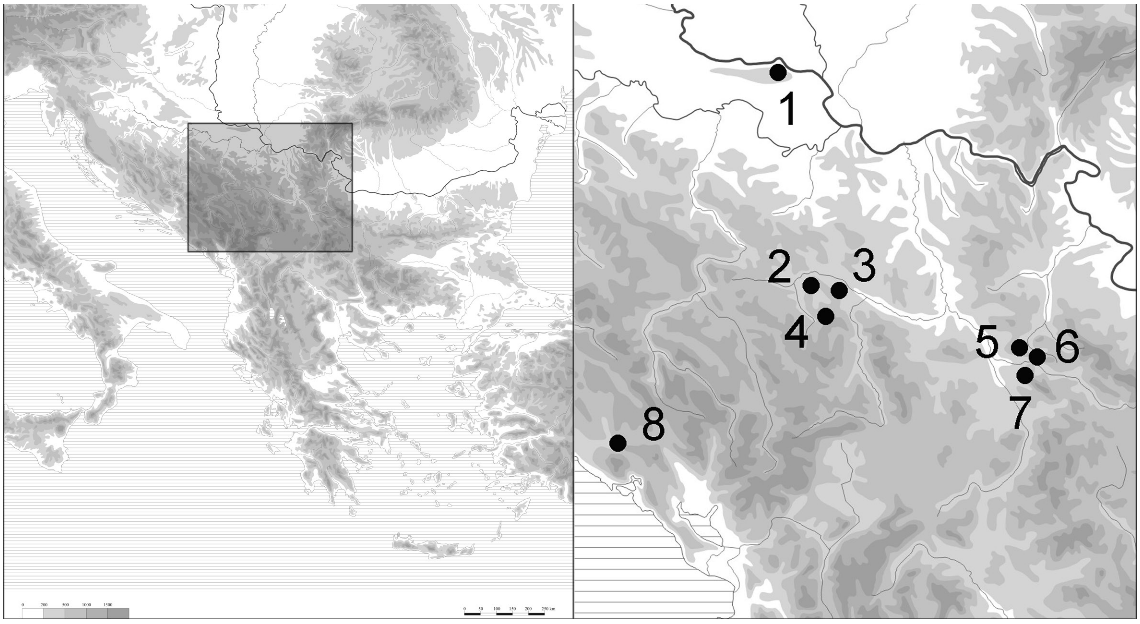

Figure 1. Palaeolithic sites in the Central Balkans: Petrovaradin fortress (1), Kosovska Kosa (2), Samaila (3), Hadži Prodanova Cave (4), Kremenac (5), Mala and Velika Balanica (6), Pešturina (7), Crvena Stijena (8).

In the course of systematic investigations of Velika Balanica between 2004 and 2014 six Middle Palaeolithic horizons have been investigated yielding numerous artifacts, fireplaces and animal bones, while a Middle Palaeolithic layer has also been confirmed in the neighboring Mala Balanica (Mihailović 2008a, 2009a). Particularly surprising was that a fragment of hominid mandible has been found in one of the lowest layers in Mala Balanica in 2006 (Roksandić et al. 2011). It has been established recently that it belongs to the species *Homo erectus* s.l. and that it is over half a million years old (Rink et al. 2013).

It is understandable that after these discoveries the intensity of investigations in the Niš valley has been increased. Preliminary site surveying was carried out of the site Kremenac near Niš, where many chipped stone artifacts sometime earlier have been registered. In the cave Pešturina in the Jelašnica gorge many layers were investigated with finds from the Middle and Upper Palaeolithic (Mihailović and Milošević 2012), in Golema Dupka near Svrljig and Meča Dupka near Cerje layers were confirmed with Middle Palaeolithic finds, while in Donja Pećina in the Sićevo gorge (Kuhn et al. this volume) remains from the Upper Palaeolithic have been discovered. The palaeoclimatic, geoarchaeological and bioarchaeological investigations intended to allow the best possible insight in climatic and ecological characteristics of that region in the Middle and Upper Pleistocene are in progress.

Sites

Kremenac

Kremenac is situated on the north fringes of the Niš valley, on the of a lake terrace of Pleistocene age. R. Whallon and Z. Kaludjerović gathered at that site a large quantity of chipped stone artifacts in the beginning of the 1990s and Z. Kaluđerović also carried out small-scale test trenching at the site. Already in first report Kaluđerović indicated with great reservations the possibility that there are also Lower Palaeolithic artifacts at Kremenac (Kaluđerović 1996) and we generally came to the same conclusion after site surveying in 2006 (Mihailović 2008b), while J. Šarić recently (2011, 2013) dated the site without much doubt to the Lower Palaeolithic period.

Judging by the incidence of tools made on asymmetrical flakes (endscrapers, denticulated and notched tools) and one preferential core, which we found in 2006, the assemblage from Kremenac actually resembles the assemblages from the Lower Palaeolithic sites in the region (Tourloukis 2010; Iovita et al. 2011). The problem is, however, in the fact that on the site was encountered large quantity of geofacts and pseudo-artifacts resulting from mechanical shattering of the chert nodules, which appear in secondary position at this location, so it is almost impossible to distinguish artifacts from the flakes resulting from natural processes when they are discovered together. This is particularly the case with ‘choppers’ and ‘proto-bifaces’ (Šarić 2011, 2013) because there are many nodules with damages identified at the site. We think, therefore, that verification of that site would be possible only when zones with diagnostic artifacts are identified and when artifacts are found in reliable stratigraphic context. In the opposite case there is a danger to draw the wrong conclusions about the character and date of the site if we rely on selective assemblage of the material.

Velika and Mala Balanica

Velika and Mala Balanica caves are situated on the fringes of the village Sićevo, 15 km to the east of Niš (N43°20’21.1’’, E22°05’11.5’’). They are located below the elevation of Brljavski Kamen on the right bank of the Nišava River at 338 meters above sea level. The distance between the caves is around ten meters and they probably belong to the same cave complex. The entrance section of Velika Balanica looks like a rock-shelter, 8 x 7 in size, and the interior section is spacious and up to 40 meters deep. Mala Balanica’s entrance is considerably smaller (1.5 x 2 m) and the floor surface of the cave covers an area of 25 x 8 m. Both caves face south.

Stratigraphy of Velika and Mala Balanica is different but there are also some similarities (Fig. 2). In Velika Balanica just underneath the surface layer was recorded complex of layers with reddish sediment and eboulis (2a-2c) followed by layers with brown, clayey and compact sediment (3a-3c). Archaeological finds have been discovered in all layers whose total depth does not exceed 1.5 m. All layers contain chipped stone artifacts and some of them are intensely tainted by charcoal particles (2b, 3b, 3c2) and in the lowest cultural layer (3c2) is discovered a zone 4-5 meters in diameter with intensive traces of burning. In Mala Balanica artifacts have been recorded only in the upper layers with brown clayey sediment (2a-2c), while layers with yellowish and reddish sediment and eboulis that belong to the middle segment of the sequence (2d-2g) and layers with dark sediment from the lower segment of the sequence (3a-3c) do not contain archaeological finds.

Concentration of finds is considerably greater in Velika Balanica where a large quantity of artifacts and fragmented animal bones were discovered. Bones of the hunted animals (ibex, red deer) with traces of tools were found together with few artifacts in layer 2b, while in the lower layers were recorded only faunal remains among which the bones of cave bear prevail. All this indicates that settling function in these two caves was significantly different. Velika Balanica was probably the base camp, which was intensely inhabited in a distinct time period, while Mala Balanica at levels 2a-2c was a temporary dwelling or habitation of specialized purpose. Preliminary analyses of fauna (Roksandić et al. 2011; Belen Marin, this volume) reveal that settling of both caves was associated with hunting red deer and ibexes.

A fragment of human mandible with three preserved molars was discovered in layer 3b at Mala Balanica in 2006. The mandible was found in the area next to the west cave wall, together with remains of dog or wolf (*Canis* sp.), bear (*Ursus* sp.), cave hyena (*Crocuta spelaea*), red deer (*Cervus elaphus*), fallow deer (*Dama dama*) and ibex (*Capra ibex*). After detailed analyses the mandible was ascribed to the species *Homo erectus s.l.* (Rink et al. 2013), while later dating using ESR method along with the methods of uranium series and infrared luminescence confirmed that the age of layer 3b is 397-525 thousand years (Rink et al. 2013).

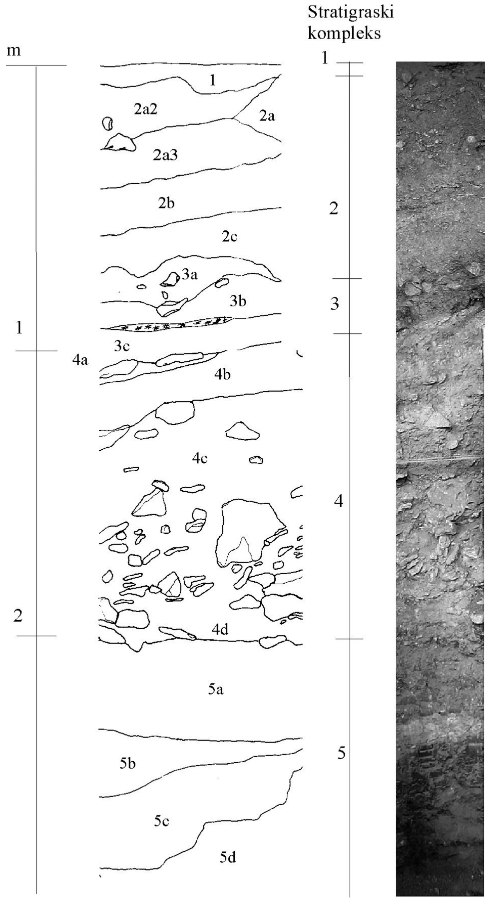

Figure 2a. Northern profile in Velika Balanica.

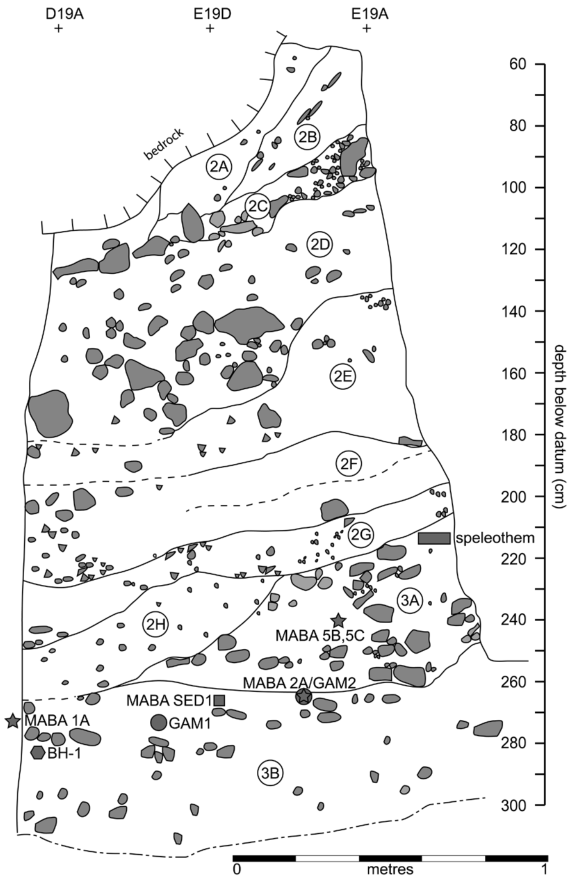

Figure 2b. Northern profile in Mala Balanica.

It has been estimated on the basis of analyses of microfauna that remains from upper layers at Mala Balanica (2a-c) and lower layers at Velika Balanica (3a-3c) date from the Middle Pleistocene (Mihailović and Bogićević in press). The remains of warm climate species (*Apodemus sylvaticus/flavicollis*, *Apodemus mystacinus*, *Muscardinus* sp., *Dryomys nitedula*, *Rhinolophus ferrumequinum*) prevail in those layers, but there were also recorded field (*Sorex minutes*) and steppic species (*Ochotona pusilla*, *Allocricetus bursae* and *Lagurus* sp.). As a similar industry has been encountered in the layers 2a-2c at Mala Balanica and layers 3a-3c at Velika Balanica it could be assumed that both caves were inhabited in approximately same period, probably in MIS 9-7.

Preliminary analysis of chipped stone artifacts was performed on the material from the first campaign that comes from the squares where stratigraphy of deposits was most comprehensible (Figs. 3a, 3b). It has been established that the industry from the lower layers at Velika (3a-3c) and upper layers at Mala Balanica is characterized by high incidence of quartz-made artifacts, struck from pebbles gathered on the river bank. Flint tools, which had been brought to the settlement as finished artifacts were recorded in much smaller quantity. For knapping centripetal and the so-called 'cortical backed' methods were systematically used (Bourgouignon 1997; Hiscock et al. 2009) aiming at striking flakes with natural back, which was either on the side or on the bottom

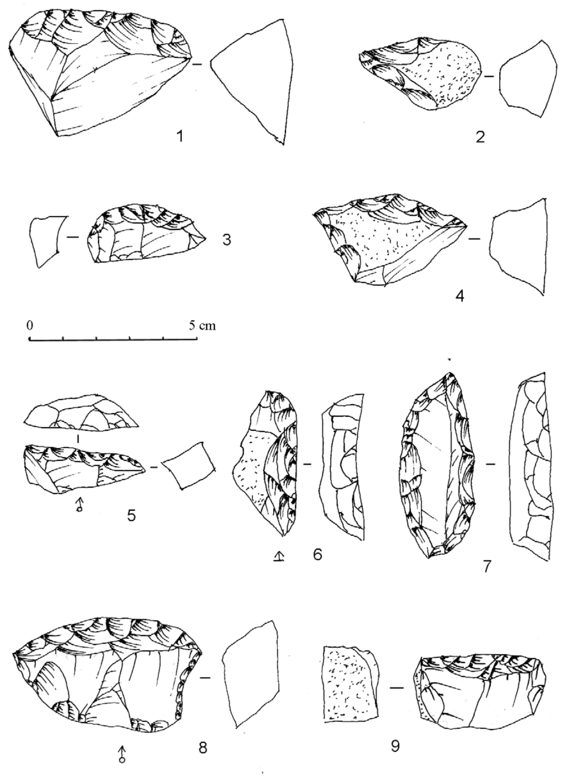

Figure 3a. Velika Balanica: retouched tools from layers 3a-3c.

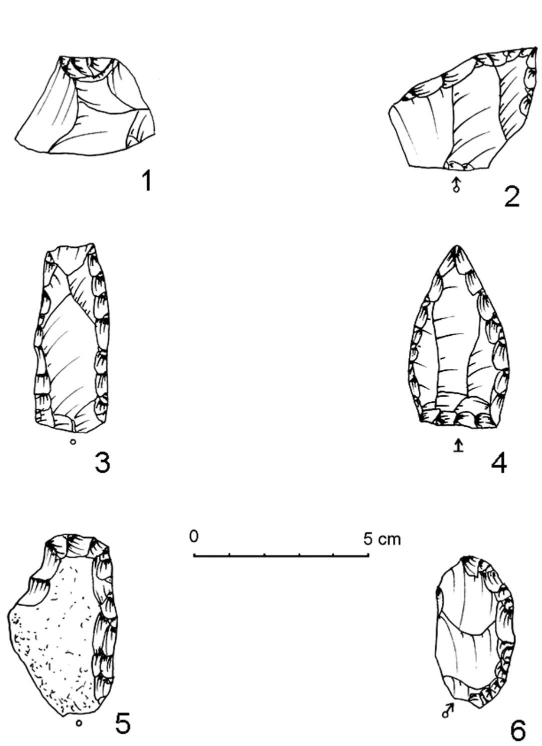

Figure 3b. Velika Balanica: retouched tools from layers 2a-2c.

end of the tool (talon-dos). Sidescrapers prevail in the structure of tools and they represent 62.1% at Mala Balanica and 33.8% at Velika Balanica. Denticulated tools are also numerous (24.1% at Mala Balanica, 25% at Velika), while other types are much less frequent. Sidescrapers of the Quina type discarded in the final phase of use were recorded in both caves and they were made on short and asymmetrical (*déjeté*) flakes with thick platform. One elongated sidescraper of the limace type was found at Velika Balanica.

Artifacts of chalcedony are considerably more frequent in the upper layers at Velika Balanica (2a-2c) but quartz artifacts still prevail. Most numerous among sidescrapers are laterally retouched specimens but there were also registered Levallois artifacts struck from preferential cores. Mousterian points and sidescrapers with bifacially retouched edges appear in small quantity both in upper (2a-c) as well as in lower (3a-3c) stratigraphic complex.

Pešturina

Pešturina cave (a.k.a. Jelašnička cave 1) is situated to the northwest of the village Jelašnica, in the mountainside area of Suva Planina (N 43° 29’44,6” E 22° 04’61,2”). The entrance to the cave is 15 meters wide, 3.5 meters high and the cave is 22 meters long. Archaeological investigations in the cave started in 2006 (Mihailović and Milošević 2012). In the course of investigations a comprehensive program of dating has been carried out including the use of ^{14}C, OSL and ESR methods (Alex and Boaretto, this volume; Blackwell, this volume).

The cave was explored in the area of around 20 square meters and up to the depth of almost 5 m. The following stratigraphy had been established: layer 1 – (surface layer); layer 2- light brown compact sediment; layer 3 – brown sediment; layer 4a – reddish and loose sediment; layer 4b – dark brown sediment; layer 4c – stratum with large rock fragments and dark brown sediment; layer 4d – grayish sandy sediment. Surface layers are very much disturbed due to human activities in recent times and also because of rodent activities.

Preliminary results of ESR dating (Blackwell et al. 2014) showed that layer 3 had been deposited before 38-40 thousand years (37.8 ± 2.0 ka) and that it coincides with MIS 3. Many dates were obtained for layer 4. One, somewhat later date obtained for horizon 4a (73.3 ± 10.3 thousand years) indicates that this horizon was perhaps deposited in MIS 4 but we still do not have confirmations for that. However, many dates were obtained for the same layer and particularly for horizon 4b indicating on average around 95 thousand years, and this coincides with MIS 5c. The lowest horizons (3c, 4b) have not yet been dated but judging by the faunal remains (V. Dimitrijević, personal communication) they reach MIS 5e age.

Numerous remains of Pleistocene fauna have been gathered in the Middle Palaeolithic layers in Pešturina. Most numerous in layer 4 are remains of horse (*Equus* sp.) and wild cattle (*Bos primigenius*); bones of red deer (*Cervus elaphus*) and ibex (*Capra ibex*) are less frequent and also remains of Rhinoceros (Rhinoceridae) and mammoth (*Mammuthus primigenius*) have been

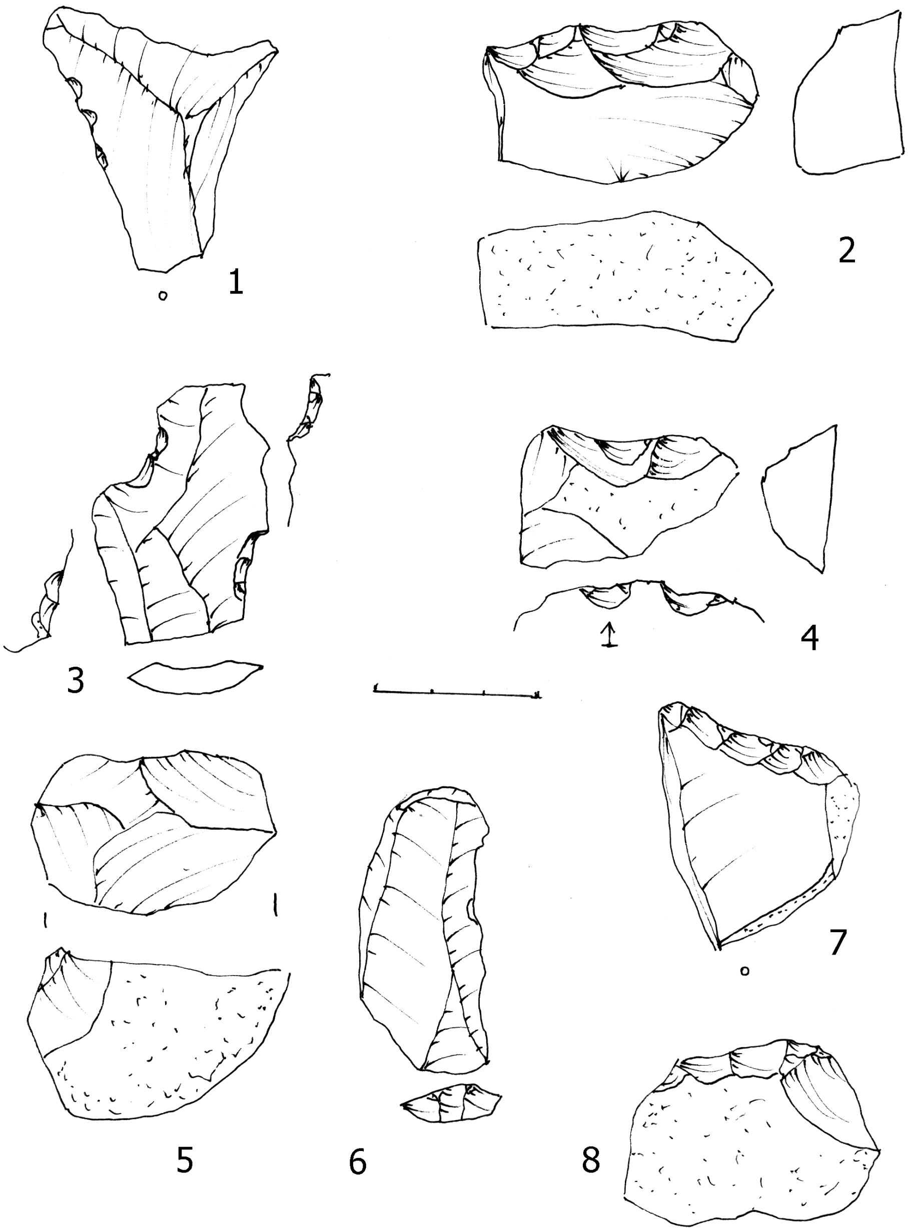

Figure 4a. Stone artifacts from Pešturina (layer 4).

found. The structure of fauna in layer 3 is not essentially different but the remains of megafauna were not discovered in that layer. Judging by the quantity of hyena remains, manner of bone fragmentation and traces of hyena's teeth on the bones it could be assumed that hyena (*Crocuta spelaea*) was the main accumulator of remains in the cave in that period. Animal bones in layer 2 are numerous but very fragmented. The remains of wild cattle (*Bos primigenius*), horse (*Equus* sp.), red deer (*Cervus elaphus*), ibex (*Capra ibex*) and wolf (*Canis lupus*) have been identified.

Around one-hundred artifacts have been found so far in layers 3 and 4 respectively (Figs. 4a, 4b). Artifacts of quartz prevail in the assemblage from layer 4 (4a-4b), while artifacts of flint and good quality chalcedony are less frequent. Only a few cores were recorded, one of them being the Levallois core, and three are centripetal cores. Use of the Levallois technique of recurrent type is confirmed by the facets on the dorsal side of Levallois flakes, while centripetal technique is indicated by one pseudo-Levallois point and one *éclat debordant*. Centripetal technique was also

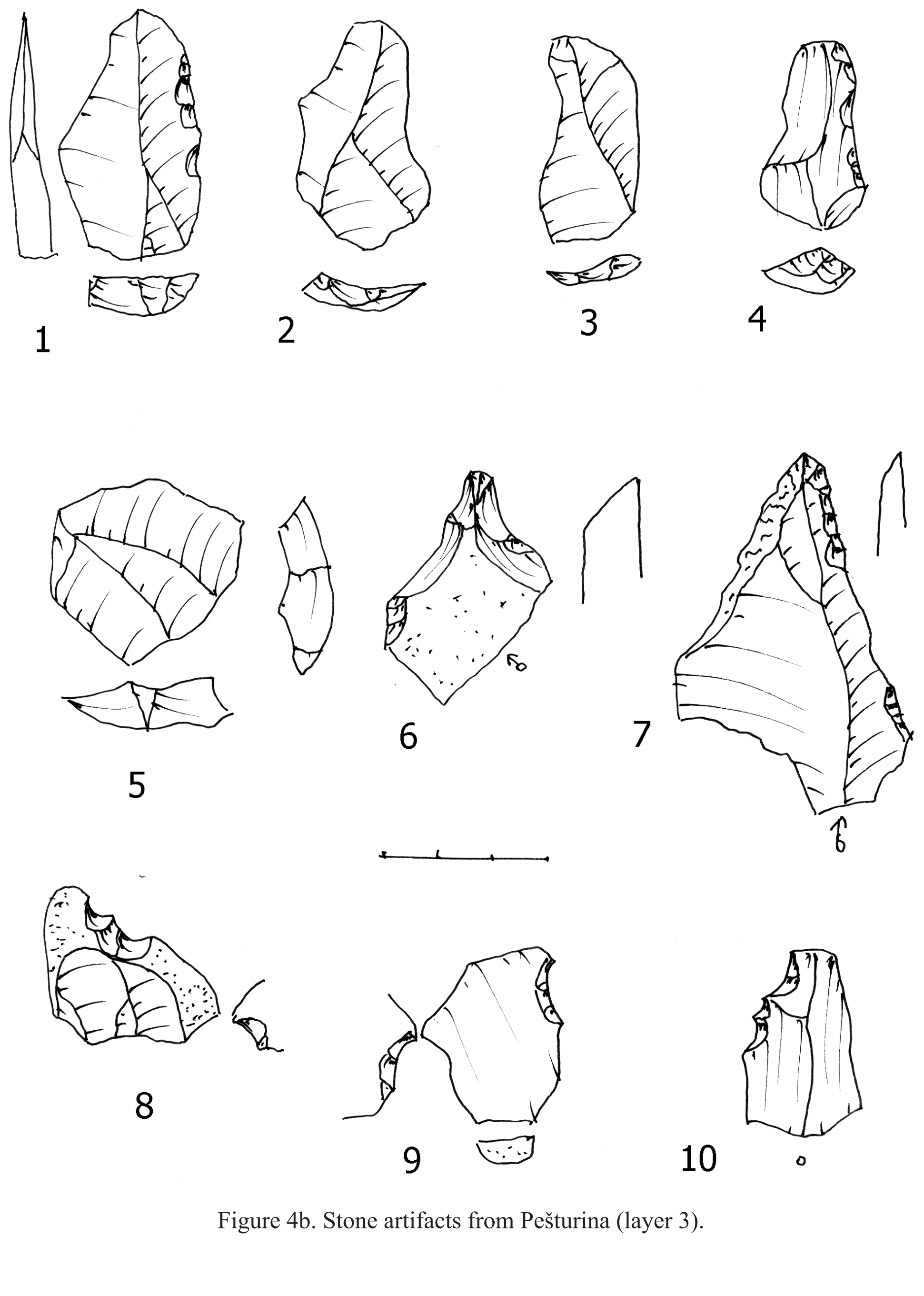

Figure 4b. Stone artifacts from Pešturina (layer 3).

used for knapping quartz pebbles as it is confirmed by flakes with broad and thick cortical platforms and laterally oriented cortex that according to the traces of use could be classified as knives with natural back. Among retouched tools sidescrapers slightly predominate over the total amount of denticulated and notched tools, while other types are registered in very small quantity. Lateral and transversal sidescrapers are equally numerous and among transversal specimens among the transversal specimens, three were confirmed with semi-Quina and Quina retouch.

Artifacts made of quartz also prevail in the assemblage from layer 3 and flint of beige-brown and gray-green color as well as chalcedony represents good quality raw materials. Centripetal knapping was practiced as it is indicated by cores but also by pseudo-Levallois points, flakes of *éclat debordant* type and knives with natural back. Products of the Levallois technology are similar to those from lower layers and these are elongated triangular points with converging facets and partially faceted platform. Denticulated and notched specimens and partially retouched flakes prevail among the tools, while sidescrapers have not been found at all.

In layer 2 of Pešturina also around one-hundred artifacts had been gathered until 2011(Mihailović and Milošević 2012). Most artifacts were made of high quality raw materials, chalcedony and translucent flint of beige and brown color. Cores were not found and knives were found in almost equal number to the flakes. Tools are considerably frequent (around 30%) and that indicates temporary settling. Backed tools prevail in the structure of tools: micro-lamellae with straight back, fragment of backed tools and microlithic bilaterally retouched points. Less frequent are retouched blades, then retouched flakes, tools with retouched truncation, perforators and sidescrapers, while there is one each of burins, splintered pieces, denticulated tools and composite tools (endscraper-point).

Discussion

The question could be asked how much the industry from Kremenac could be related to the Lower and Early Middle Pleistocene, i.e. to the initial phase of settling in the Balkans. Finds from that period have only been confirmed in the Balkans in the Kozarnika cave in Bulgaria (Guadelli et al. 2006; Tourloukis 2010; Sirakov et al. 2011; Iovita et al. 2012), where endscrapers, sidescrapers and denticulated tools made on irregular flakes and lumps of raw material have been recorded. In the terminal Lower Palaeolithic layer (11a), which is roughly dated to the beginning of the Middle Pleistocene, the technique of knapping of preferential flakes also appears and it conceptually precedes the appearance of the Levallois technology (Sirakov et al. 2010), and amorphous bifacially knapped specimens, which roughly resemble bifaces, have also been found (Guadelli et al. 2006).

Artifacts from the late Lower or early Middle Palaeolithic appear also on the river terraces of Great, West and South Morava (Heffter, this volume). In the West Morava plain, in the area of Čačak-Kraljevo valley, whole series of lithic scatters, which could date from those periods have been recorded on the surface and particularly interesting sites are Samaila-Vlaška Glava near Kraljevo (Mihailović and Bogosavljević-Petrović 2009) and Kosovska Kosa, Ježevica and Viljuša near Čačak (Mihailović et al. this volume). At all these sites are well represented choppers as well as Kombewa and preferential ("proto Levallois") cores made on pebble fragments or thick flakes. The sites near Čačak and particularly Kosovska Kosa reveal a more prominent Lower Palaeolithic character, while the Levallois component is much more prominent at Vlaška Glava and other sites closer to Kraljevo. The reason for this lies perhaps in the fact that sites in the vicinity of Čačak are closer to the primary and secondary chert deposits located on the slopes of the Jelica Mountain.

Velika and Mala Balanica offer considerably more information about character of the industry from the end of the Lower and the beginning of Middle Palaeolithic. In layers 3c2 and 3c at Velika Balanica thick flakes of 'Clactonian' type with very open platform angle (more than

120°) and Clactonian notches were encountered in somewhat larger quantity but we must have in mind that the industry from layers 3a-3c at Velika Balanica and layers 2a-2c at Mala Balanica is of conspicuously Charentian character (Bourguignon 1997). The Quina method had been used for knapping; transversal sidescrapers are more numerous than lateral ones, while Quina sidescrapers are very characteristic.

Taking into account the potential age of the site, the industry from Balanica is best corresponding to the proto-Charentian from complex B-E at Karain generally dated to the period before 300-330 thousand years (Kozłowski 2002). There was also registered a Clactonian component in the lower layers (complex B); middle layers (B-E) yielded sidescrapers on thick flakes made by Quina retouch and denticulated tools, while in the upper complexes (F-I) appear Levallois artifacts (Otte 1998; Kozłowski 2002). Proto-Charentian at Karain was related, on the basis of those elements and presence of bifacial tools, to Acheulo-Yabrudian of the Near East (Bourgouignon 1997; le Tensorer 2005). If the Middle Pleistocene date of industry from layer 2 at Mala Balanica and layer 3 at Velika Balanica is to be confirmed it would mean that industries of that type covered considerably larger territory than it has been assumed and that there is ground for the hypothesis that Charentian technology from southwest Asia spread toward southeast and central Europe in a certain moment of time.

The date of upper layers at Velika Balanica (2a-2c) is not known so far but it is not impossible that they also date from the end of the Middle Pleistocene. In that case Velika Balanica could be ascribed to the sites where the earliest appearance of the Levallois technology in the Balkans has been recorded (Crvena Stijena XXXI-XXIV, Kozarnika) which were dated to MIS 6 (Kozlowski 2002; Guadelli et al. 2005)..

When, however, Pešturina is concerned, the assemblage from layer 4 that by all appearances dates from MIS 5 is yet another proof that Charentoid, mostly quartz industries with a greater or lesser prevalence of the Levallois component existed in the last interglacial and early glacial up to MIS 4 in the Balkans. Charentian elements are very frequent at the sites in the northwest of the Balkans and in south Pannonia (Krapina, Vindija, Betalov Spodmol, Erd), while the elements of typical Mousterian are somewhat more prominent in the central parts of the Balkans (Gábori 1976; Mihailović 2008a). On the other hand, the assemblage from layer 3 could be associated with technologically impoverished industries from MIS 3 some of which, depending on proportional frequency of the Levallois artifacts, denticulated tools and small-size tools, were classified as non-Levallois facies of typical Mousterian and some as denticulated Mousterian or micro-Mousterian (Basler 1975).

Because of the layer disturbance, dates for layer 3 in Pešturina cover a rather broad time span including also the period, which obviously corresponds to the Gravettian horizon at the site (Alex and Boaretto, this volume; Blackwell, this volume). Most of the dates correspond to the period between 36 and 40 ka ^{14}C BP which is the time when the Middle Palaeolithic comes to an end also in other parts of Europe (Higham et al. 2014). Some dates, however, indicate the period between 30 and 40 ^{14}C ka BP and ESR dating revealed that layer 3 might date from 38-39 ka ^{14}C BP and that corresponds to the radiocarbon age of around 35 ka ^{14}C BP. If it turns out to be correct it is not impossible that the Middle Palaeolithic in Pešturina coincides chronologically with the beginning of the Upper Palaeolithic not only in Bulgaria but also in Serbia – considering that Baranica and Tabula Traiana Cave are dated to 35-36 ka ^{14}C BP (Mihailović et al. 2011; Borić et al. 2012). So it means that Pešturina was situated either in the zone of interaction between the Neanderthals and modern humans or outside that zone on the border of expansion of the Upper Palaeolithic populations.

The zone of interaction, as it seems, has been already confirmed in Bulgaria. The industry of Upper Palaeolithic type, which is associated with anatomically modern humans, has been encountered in layer VII of Kozarnika, while the industries of transitional type, which are associated with the Neanderthals, are confirmed at Temnata Dupka and Bacho Kiro. On the other hand shifting of the border of expansion is indicated by a poorly defined trend of decreasing date for the earliest Upper Palaeolithic sites from the east toward the west of the Balkans. If it turns out to be correct then we could really speak about the Neanderthal refugium in central and western parts of the Balkans.

There is, however, also third explanation, which does not entirely exclude the previous two. If it turns out that the end of the Middle Palaeolithic took place at approximately the same time (before 35-40 ka) then other reasons probably had an impact on that. Some authors think that the mega-eruption of a volcano in Phlegraean Fields near Naples before 35 thousand radiocarbon (40 thousand calendar) years could have accelerated the end of Middle Palaeolithic and contributed to the extinction of the Neanderthals (Giaccio et al. 2008; Fitzsimmons et al. 2014). Nevertheless, it must be taken into account that the eruption happened not before the later phase of expansion of Upper Palaeolithic populations (Higham et al. 2013), that it covered a restricted area and that its effect was probably not long-lasting (Mihailović 2009b). This is also indicated by among other things the continuity in settling in parts of the peninsula not directly being affected by the eruption.

We also suggested earlier the possibility that the eventual discovery of the Aurignacian sites in the south parts of the central Balkans could bring into question the hypothesis about the Danubian corridor and show that the Balkans had been settled from different directions. First results of investigations of Donja Pećina in the Sićevo gorge really indicated the presence of technology, which conditionally speaking could be associated with the Aurignacian (Kuhn et al. this volume). Yet, it seems by all appearances that it is the case of late or Epiaurignacian, which probably dates from the period immediately before or after the beginning of the last glacial maximum.

From approximately the same or somewhat later period originate also the earliest Gravettian industries in the central and east Balkans (Kozarnika IVb) dated to the period before 26 ka ^{14}C BP (Tsanova 2003). Some of them could be related to central European facies (Willendorfian, Pavlovien), so the question could be asked whether at the beginning of last glacial maximum the Gravettian communities shifted from the Pannonian basin southward or the communities in the north of the Balkans intensified in that period contacts with central European populations (Mihailović and Mihailović 2007). In favor of the second assumption speaks the fact that remains from Pešturina and Hadži Prodanova Cave indicate that Gravettian communities inhabited central parts of the peninsula even before the greatest cold spell.

Population density of mountainous areas of the Balkans decreased in the period of the last glacial maximum as confirmed by scarce finds from most of the sites. In that period the Epigravettian communities probably retreated to the sheltered areas in the peninsula interior, in the coastal area and south parts of the Balkans (Miracle 2007). All that changed at the beginning of late glacial when Epigravettian communities recolonized hilly and mountainous areas (Mihailović 2007). It is slightly surprising that sites from that period have not been so far confirmed in Serbia with certainty. We are, however, certain that it is the result of poorly investigated regions and that it could be expected to encounter the remains from that period in the future.

Conclusions

Investigations of Velika and Mala Balanica and Pešturina in the Niš valley and other sites in central parts of the Balkans cast new light on evolutionary and cultural changes in the Middle and Upper Pleistocene. If we would try to summarize them we could emphasize the following:

- Anthropological remains from Mala Balanica (*Homo erectus* s.l.) dating from the time half a million years ago show that the Balkan Peninsula in the glacial periods was not isolated from the rest of Eurasia but that it relied on a so-called central region of distribution in Eurasia where, as some authors think, changes had been taking place independently from the processes in Africa (Dennell et al. 2010, 2011). Unfortunately, there were no archaeological finds in the layer with the human fossil.

- Remains from Velika and Mala Balanica and sites in the West Morava valley offer initial insight in the technological changes at the end of Lower and the beginning of Middle Palaeolithic. They bear witness to the fact that in the central Balkans could also be expected industries with tools made of pebbles and flakes, that Levallois technique was introduced rather early and that at approximately same time did appear Charentian industries, which could be related to the Proto-Charentian of Karain and Yabrudian of the Near East (Otte et al. 1998; le Tensorer 2005). If the Middle Pleistocene date for the Charentian in Balanica is confirmed it will show that 'eastern Charentian' was not geographically isolated but that Charentian technology from the Near East spread toward central and southeast Europe.

- The industry from layer 4 at Pešturina that is generally of Charentian character supplements the picture of heterogeneous character of Mousterian industries from the last interglacial and early glacial where both Charentian and Levallois elements were present (Mihailović et al. 2011).

- In MIS 3 in the central Balkans appear undifferentiated industries within which are present to the more or less degree the elements of typical, denticulated and micro-Mousterian. This is confirmed by the finds from layer 3 at Pešturina that are, judging by absolute dates, somewhat earlier or synchronous with the initial Upper Palaeolithic (Kozarnika) and transitional industries (Bacho Kiro, Temnata) in Bulgaria. Future investigations will reveal whether or not Pešturina is located within the zone of interaction of the Neanderthals and modern humans.

- Finds from the early Aurignacian have not been recorded, while finds from Donja Pećina in the Sićevo gorge suggest the possibility that this area had been inhabited by the bearers of late Aurignacian or Epiaurignacian after 30th millennium BP (Kuhn et al. this volume). On the other hand, finds from layer 2 at Pešturina suggest the assumption that central parts of the Balkans were inhabited at the beginning of the last glacial maximum.

Investigations of the Palaeolithic in central parts of the Balkans have raised as we see a large number of questions. Because of that we must emphasize that quoted conclusions are only preliminary and that most of them should be confirmed in future investigations.

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MIDDLE PLEISTOCENE SUBSISTENCE IN VELIKA BALANICA, SERBIA: PRELIMINARY RESULTS

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Abstract: Preliminary zooarchaeological results of the macrofaunal assemblage from the Serbian site of Velika Balanica are presented here. The site contains lithic artefacts corresponding to Charentian and typical Mousterian, evidencing the first human occupations during the Early Middle Pleistocene of the Central Balkans, likely during an interglacial stage (MIS 7 or MIS 9). This paper offers the first insights on the paleoecoconomy practiced in the region, leading to a better comprehension of the human subsistence and its relationship with the available resources and palaeoenvironmental conditions. Thus, the taphonomy of the deposit indicates a systematic consumption of medium-size mammals with an intensive exploitation of carcasses, as well as a residential use of the cave.

Keywords: Middle Pleistocene, Serbia, Paleoecoconomy, zooarchaeology, taphonomy

Introduction

Information about the palaeconomic behaviour carried out by human groups during European Middle Pleistocene is rather limited due to the scarcity of well-preserved faunal assemblages and the lack of taphonomic analysis in comparison with Late Pleistocene times. In fact, the macrofaunal and microfaunal assemblages recovered from Middle Pleistocene sites have been interpreted mainly from a paleontological and environmental perspective. Thus, animals recovered in archaeological contexts dated during Maritime Isotopic Stage 7, 8 and 9 (350 – 190 kyr BP) such as Torre in Pietra upper beds, Vitinia and Sedia del Diavolo (Caloi et al. 1998), Weimar-Ehringsdorf lower travertine levels (Kahlke 1995), Maastricht-Belvédère Unit IV (Van Kolfschoten 1985), only provide information about climatic and environmental conditions. As a result, our understanding of human palaeoeconomic behaviour is still unclear for this period except for a few cases where taphonomy has been applied such as in Wallertheim (Gaudzinski 1995), Orgnac 3 (Moncel et al. 2005) or Galeria (Huguet el al. 2001))

Unlike other European regions, the central Balkans is a poorly studied area in terms of Palaeolithic research during Middle and Late Pleistocene. However, the abundance of caves and rock-shelters in Serbia is overwhelming, making the region suitable for paleontological and archaeological accumulations as evidenced by the abundant record of cave bear hibernation nests (Cvetkovic and Dimitrijevic 2014). In this scenario, recent Palaeolithic research conducted in Serbia has provided new insights about early Prehistory in this part of Europe (Mihailovic et al. 2011). Remarkably, the discovery of the Balanica complex (formed by Mala and Velika Balanica caves) located in south-eastern Serbia has revealed an interesting stratigraphic sequence where, apart from a great deal of mammal fossils and flint artefacts, the first Middle Pleistocene human remains in eastern Europe have been recovered (Roksandic et al. 2011).

The Mala Balanica sequence has been dated between 397 and 525 ka (Rink et al. 2013) while TL dating in Velika Balanica is still on-going, although microfaunal remains also suggest a Middle Pleistocene chronology with interglacial species mostly represented. In addition, the lithic artefacts found at Velika Balanica show technological similarities with the Charentian tools found at Mala Balanica.

In this paper, a preliminary archaeozoological study of Velika Balanica macrofaunal assemblage is presented. This study provides the first paleoecoconomic data of the Middle Pleistocene human occupations of the region, leading to a better comprehension of their strategy of subsistence.

Materials and methods

Velika Balanica cave is located on the right side of a narrow gorge near Sićevo (southeastern Serbia) at an elevation of 332 m.a.s.l. and 100m above the Nišava River (see Figure 1). It is a karstic cavity facing SSW and overlooking to the West the large fluvial plane of the Morava River. It is separated 7m from the entrance of the smaller Mala Balanica cave with which it forms the Balanica Cave Complex and where a *Homo* sp. human mandible was discovered (Roksandic

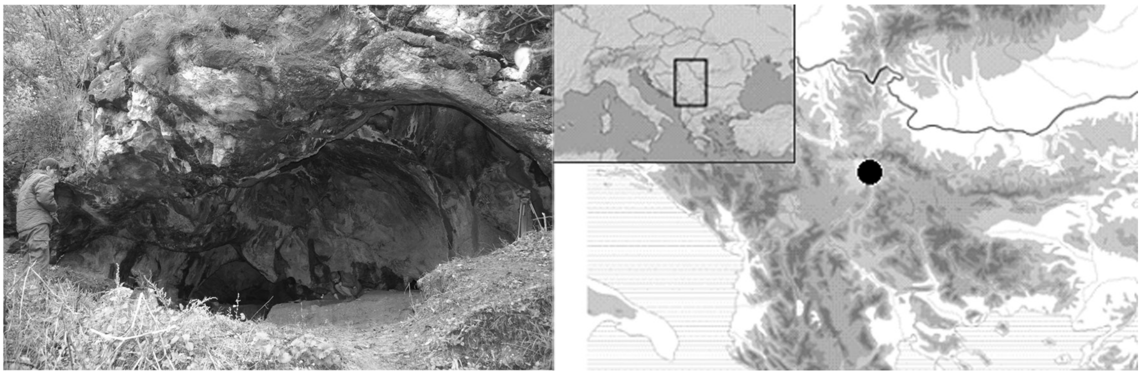

Figure 1. Outside view and location of Velika Balanica in Serbia.

et al. 2011; Rink et al. 2013).

Velika is a relatively big cave of around 400 m^2 where the archaeological excavation occupies over 30m2. The stratigraphic sequence is 3 m deep and is divided into five levels with several sub-levels (Figure 2). Level 1 is sterile; Level 2a-2c contains typical Mousterian artefacts, while in Levels 3a-3c Charentian industries are represented (Mihailović 2008). Currently Levels 4 and 5 are being excavated. Samples for TL (by Norbert Mercier) and ESR (by Bonnie Blackwell) were taken from Layer 2 and 3a and their analyses are on-going. The similarities between Charentian lithic assemblages in Velika and Mala Balanica and microfaunal results (Mihailović and Bogicević in press) suggest that layer 3a might correspond to the late phase of Middle Pleistocene, or probably to the interglacial MIS 9 or MIS7 - considering the Proto-Charentian character of industry and parallels with Karain (Otte et al. 1998) which is also tentatively dated to 330-300 ka (Kozłowski 2002). Thus, Velika Balanica could be from the same age or even older.

The material studied here belongs to levels 2 and 3 (2a+2a2+2a3, 2b, 2c, 3a, 3b and 3c) and corresponds to the frontal part of the cave. Only macromammal remains were considered in this study. The analysis was conducted in the Laboratory of Bioarchaeology at the University of Belgrade with the help of its comparative osteological collection. Due to the same cultural and climatic origin, all levels have been grouped together in order to increase sample size and boost palaeoeconomic interpretations.

The identified bones were quantified by using the following indices: Number of Identified Specimens (NISP), Minimum Number of Individuals (MNI), Minimum Number of Skeletal Elements (MNE) following Marín-Arroyo (2009a) and Minimum Animal Units (MAU) (Binford 1978). Due to the high fragmentation rate, the specimens that could not be identified taxonomically by any characteristic landmark were grouped together according to their size into large (including aurochs and horses), medium (including red deer and ibex) and small (including chamois) mammals.

Each bone (over 3cm long) was examined under a LEICA S8 APO stereoscope with 10x eyepieces in search of visible taphonomic alterations, such as butchering-marks [Binford (1981) and Pérez Ripoll (1992)], hammmerstone percussion marks (including conchoidal notches, Bunn 1981; Capaldo and Blumenschine 1994; Pickering and Egeland 2006), type and angle of fracturing (fresh-green versus old-dry, Villa and Mahieu 1991), thermoalterations and trampling (Behrensmeyer et al. 1986). In order to know if the breakage pattern of the assemblage was the result of marrow extraction, correlations between NISP/MNE and Marrow Index (Binford 1978) were done. Carnivore pits, digestions and rodent marks were identified too (Binford 1981; Stiner 1994) as well as physic-chemical alterations, such as weathering (Behrensmeyer 1978), root etching, carbonate deposits (Shipman 1981; Fisher 1995) and mineral manganese coatings (Marín-Arroyo et al. 2008) Taxonomic abundance was evaluated both in terms of NISP and MNI. The ungulate mortality pattern (i.e. juvenile, prime or old adult) was assessed by both dental eruption and wear stage following Stiner (1991, 2005). Pielou's evenness index (1966) was used to assess skeletal completeness for each size-class.

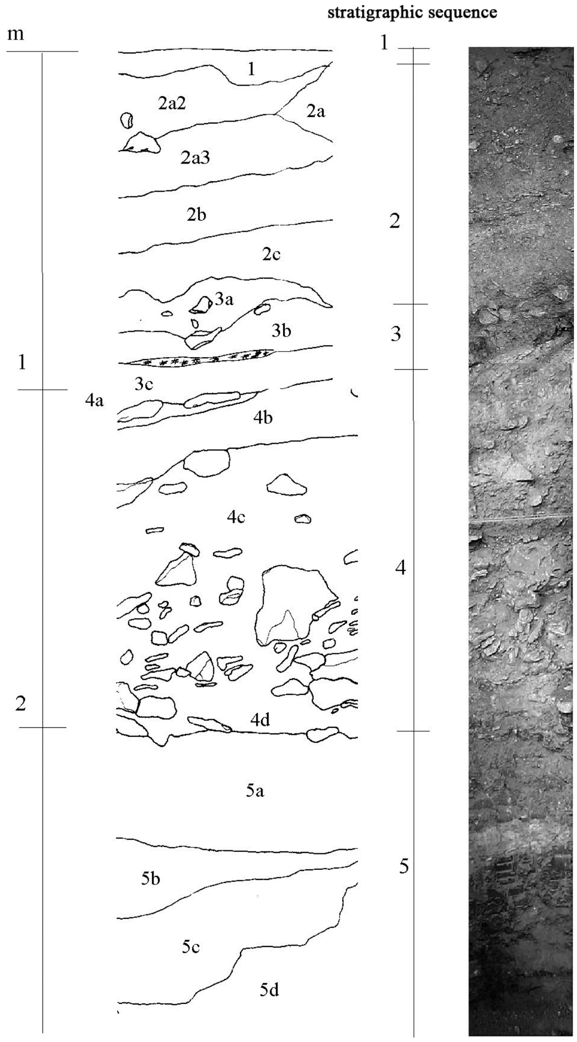

Figure 2. Stratigraphic sequence of Velika Balanica.

Results

Faunal assemblage

The analysed assemblage comprises 10,132 faunal remains, 86.3% of which are non-identifiable, being mostly shaft fragments with an average length inferior to 3cm. Due to the highly fragmented nature of the deposit, only 462 and 607 bone remains (excluding diaphysis fragments) have been identified taxonomically and anatomically, respectively. Table 1 shows the distribution of NISP and MNI values per level and species.

Levels	2a+2a2+2a3	2b	2c	3a	3b	3c	Total
	NISP/MNI						
Stephanorhinus kirchbergensis		2/1	1/1		1/1		**3/2**
Bos/Bison				1/1			**1/1**
Equus ferus				1/1		3/1	**4/2**
Capra ibex	31/4	104/4	5/1	7/2	13/1	5/1	**165/13**
Cervus elaphus	24/2	185/3	8/1	15/1	11/1	3/1	**246/9**
Rupicapra rupicapra	8/1	19/1	2/2	2/1	3/1	1/1	**35/7**
Total Ungulates	**63/7**	**310/9**	**16/5**	**26/6**	**28/4**	**12/4**	**455**

Felis silvestris	1/1						**1/1**
Canis lupus				1/1	2/1		**3/2**
Ursus sp	1/1	1/1					**2/2**
Total Carnivores	**2/2**	**1/1**	**-**	**1/1**	**2/1**	**-**	**6**
Large-sized mammal		7	6	9	6	2	**30**
Medium-sized mammal	90	574	11	67	98	43	**883**
Small-sized mammal	3	2					**5**
Indeterminate	1708	5260	303	745	655	81	**8752**
Total	**1866**	**6155**	**336**	**848**	**789**	**138**	**10132**

Table 1. Assemblage quantification of Velika Balanica.

As can be seen, the faunal spectrum of ungulates at Velika Balanica is mainly represented by red deer (*Cervus elaphus*) and ibex (*Capra ibex*) followed by chamois (*Rupicapra rupicapra*) which is in agreement with the topographic location of the cave. Other identified ungulates, which appear in a moderate proportion, are horse (*Equus ferus*), rhinoceros (*Stephanorhinus kirchbergensis*) and bovines (*Bos primigenius – Bison priscus*). Carnivores are represented by bear (probably *Ursus spelaeus*), wolf (*Canis lupus*) and fox (V*ulpes vulpes*). These taxa are typical of forested and grassland environments, which are coherent with the moderate temperatures and the palaeoenvironment reconstructions associated with MIS7-9interglacial phases. Thus, according to NISP and MNI the most important contribution to the diet would have come from red deer and ibex, while large fauna would have played a secondary role.

The ungulate mortality pattern was only assessed by tooth eruption and wear stages due to the high fragmentation of the assemblage. Red deer, ibex and chamois teeth provided a relatively large dental sample belonging to 9, 12 and 7 individuals respectively that reflects a pronounced predominance of prime-age individuals beyond the normal pattern observed in the living structure. This would mean that hunting strategies were focusing on the more productive animals, which is an evidence of some kind of specialisation. However, seasonality was difficult to assess due to the small teeth sample. Only in Level 2b several red deer milk teeth might indicate a summer use of the cave. As a result, human groups in Velika would have had a clear specialised economy focused on herds of deers, probably grazing in the Morava fluvial plain, which is located not more than 5 km to the SSW of the cave, and on ibex and chamois living around the site. This reflects a rather narrow diet, where the role of large mammals is low, and where the location of the cave heavily influences human decisions.

Skeletal profile representation

Regarding the skeletal part representation teeth represent a 15% of the total MNE. Apart from them, the vast majority of skeletal elements in the assemblage belongs to the appendicular skeleton (77%) followed by axial remains (14%) and heads (9%). This is already an interesting result, as it points towards an apparent mayor contribution of high-utility parts to the site.

As Figure 3 shows, medium ungulates are more evenly represented than other game, although the low representation of large and small mammals could have hidden a similar pattern. Taking into account that there are 28 different anatomical units, Pileou's evenness index have been also calculated for each body-size class. The highest value (0.85) corresponds to medium mammals followed by small and large preys (0.70 and 0.56 respectively), pointing toward a more complete contribution of the former group. Spearman's correlations between %MAU of large, medium and small ungulates have been also calculated in order to better evaluate dissimilarities. As a result, a significant positive correlation has been found between medium and small mammals (ρs=0.498, p=0.013), whilst there is no relationship between them and large mammals, pointing towards a probable similar transport strategy between medium and small prey, with large ones probably more selectively contributed (although the small size of the latter sample can also affect the analysis).

Taphonomy of the deposit

The taphonomical analysis was essential to identify the accumulating agent responsible for the assemblage, as well as to estimate the role played by post-depositional alterations. In this sense, Table 2 quotes the percentage of biostratinomic and diagenetic alterations recognized in the assemblage. As can be seen, the abundance of butchery and breakage marks and thermoalterations clearly point towards an anthropogenic origin of the deposit. First, the butchering marks including skinning, dismembering and defleshing are located on approximately 9.2% of the bones identified taxonomically, with 90% of the cut-marks in fragments of limb bones.

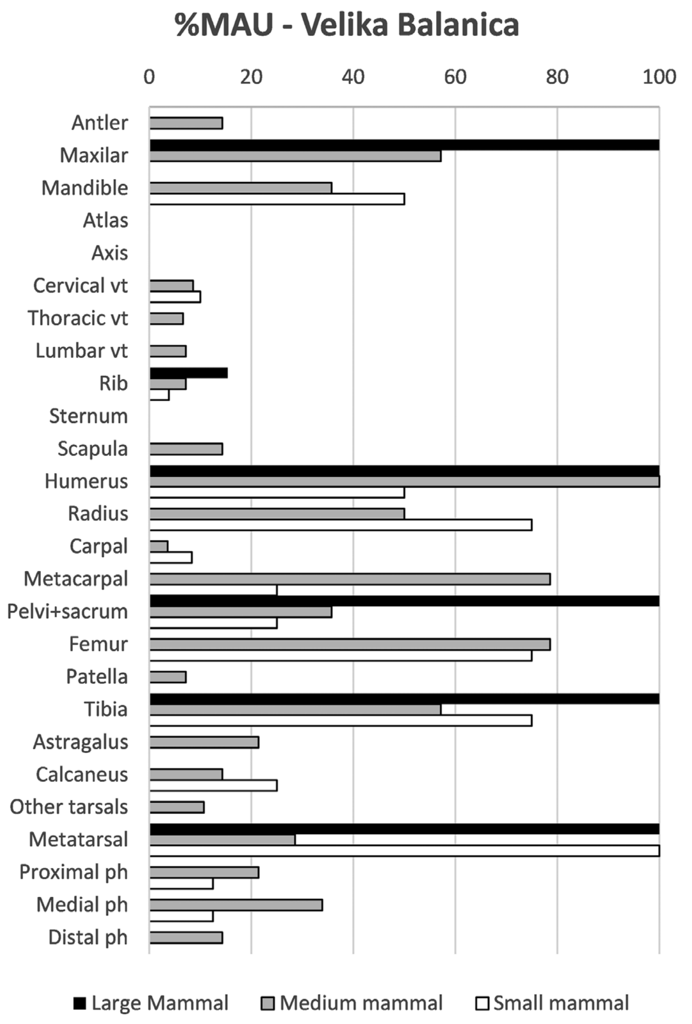

Figure 3. Skeletal profiles of large, medium (distinguishing between red deer and ibex too) and small mammals in Velika Balanica in terms of %MAU.

	NISP	%NISP
Human modifications		
Cut marks	185	1,8
Impact scar	28	0,3
Green-bone fracture	603	5,9
Thermoalterations	3135	30,9
Carnivore and rodent activities		
Gnaw-marks	18	0,2
Digested	2	0,0
Rodent-marks	9	0,1
Other biostratinomic and diagenetic alterations		

Weathering	689	6,8
Trampling	57	0,6
Insect/fungus	3	0,03
Root etching	31	0,3
Carbonate	145	1,4
Coating (mineral)	214	2,1
Dissolution	861	8,5
Polishing	5	0,05

Table 2. Taphonomic modifications in Velika Balanica. % NISP given in relation of the total NISP of the assemblage (n=10,132).

Second, 29.3% of the remains identified taxonomically shows evidence of human percussion whilst fresh, with oblique angles and curved profiles, while 1.3% presents impact notches. Among fresh-broken remains, several splinters associated with a negative flake scar on the medullary surface as well as some long-bone shaft remains with hammerstone percussions were clearly identified. In addition, there are abundant signs of marrow extraction in all levels. In fact, the degree of fragmentation (measured as the quotient between NISP and MNE) correlate positively and significantly ($\rho s=0.686$, $p<0.001$) with Marrow Index for medium mammals, the most abundant species, which would mean that red deer and ibex were intensively exploited to obtain marrow grease.

Also, fire traces are very common within the assemblage. 31% of the complete bone set of anatomical elements (shafts, cranium and axial) are affected by thermoalterations. Besides, those elements show different colour intensities: brown (7.1%), brown/black (51.3%), black (9.9%), black/white (0.8%), grey (9.1%) and white (21.9%). This abundance of burnt traces could be related to intense cooking and, probably, to hygienic activities in order to clean the living floors of the cave.

Unlike human-derived alterations, the presence of carnivore and rodent modifications is rather low. Less than 1% of the taxonomically identified remains display tooth marks or digestive traces, which could be interpreted as an occasional and secondary access to the carcasses abandoned by human groups. The action of small rodents was identified just in nine remains, including a rhinoceros tooth. Finally, the pressure of the sediment and the presence of debris was recognized by the trampling marks visible along the stratigraphy sequence, above all, in Level 2b. Among the whole assemblage, the existence of carbonates (1.4%), dissolutions (8.5%), and manganese coatings (2.1%), would also indicate successive ponding episodes, whereas weathering (6.6%) would evidence a sub-areal exposition of some bones in surface.

Conclusions

The faunal assemblage of Velika Balanica provides the first archaeozoological data in Serbia regarding the hunting efficiency related to Middle Pleistocene human groups during MIS7-9. The taphonomy of the assemblage clearly proves the anthropogenic origin of the deposit, allowing thus palaeoeconomic interpretations. Taxonomical abundance shows the main role that medium mammals would have had in the human diet. The palaeeconomy at Velika Balanica was mainly based on the consumption of red deer and ibex, thus resembling other Middle Palaeolithic sites (Patou-Mathis 2000). However, unlike them, large game was not the main focus of the strategy of subsistence here, although prime-age individuals continue to predominate. This trend can be explained by the location of the site, rather far from large fluvial plains, which would have meant lower productivity of these animals due to higher travel and transport costs (Cannon 2000).

This degree of specialization is not uncommon in other interglacial sites of the Middle Pleistocene, although it is more associated with large game consumption in open land settlements [see for example the overwhelming abundance of bovid remains in Russian sites of Il'skaja (Hoffecker et al. 1991) and Sukhaja MeEetka (Vereseagin and Kolbutov 1957), French sites of Mauran (Girard and David 1982), Champlost (Farizy and David 1989, 1992), La Borde (Jaubert et al. 1990) and the German site of Wallertheim (Gaudzinski 1995)], probably due to a tendency towards mass killing episodes, favoured by the large adjacent fluvial plains. The trend towards medium mammals hunting is more pronounced when mountain biotopes are in the vicinity of the site [see for example the French site of Abri aux Puces (Slimak et al. 2010) and the Levant sites of Qesem (Stiner et al. 2009), Misliya (Yeshurun et al. 2007) and Tabun D (Marín-Arroyo 2013)]

Despite this apparent efficient economy, the transport strategies adopted with carcasses do not agree with taxa preference. As have been verified, prey size would not have affected human decisions at Velika Balanica, at least as far as medium and small mammals are concerned (the small sample of large mammals is not seen as statistically significant to draw well-founded conclusions). The location of prey was also not apparently relevant. In both cases, carcasses were contributed complete or with a slight processing/discard of axial skeleton at the kill-site, which is not coherent with optimum behaviour (Marín-Arroyo 2009b) This fact, in turn, clearly indicates the residential use of the cave, as the effort of transporting medium mammals to the site would only be explained by its later consumption. Once medium-size mammals were contributed to the settlement, a thorough exploitation of bone marrow took placed. Whether this was the final intention of contributing the whole skeleton or not to the base-camp remains unknown.

To sum up, Velika Balanica faunal assemblage is an interesting counterpoint to the more common open-land sites of northern and central Europe during the first part of the Middle Palaeolithic. It held a dual economy focused on medium mammals, a fact that can be related to the topographic relief of the area. Logistic mobility was also rather high, which would mean an intense residential use of the cave. Transport strategies of carcasses point towards an almost complete contribution of ungulates regardless of body size and hunting location, which could be indicative of a sub-optimal behaviour. Thus, the efficiency of the palaeoeconomy practiced by Velika Balanica inhabitants would be lower than the one observed in the Upper Palaeolithic record and in ethnographic studies.

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SEEKING FOR THE ORIGINS OF PALEOLITHIC GRAPHIC ACTIVITY: ARCHAEOLOGICAL ROCK ART SURVEY IN SERBIA

Aitor Ruiz-Redondo

Abstract: In 2012 a new survey Project aiming at the investigation of the Paleolithic rock art in Serbia was started. The primary working hypotheses is that the first anatomically modern humans (AMH) to reached Western Europe already possessed an incipient graphic and symbolic behavior. Therefore, evidence of early graphic activity should be found along the path followed by the first AMH to colonize Europe. During two months of survey, the walls of several known prehistoric cave sites located in different zones of Serbia were explored. In this paper the background, methodology and some preliminary results are presented. Among these results, the discovery of the first cave site in the region with possible Paleolithic graphic representations is described and its chronological attribution is discussed.

Keywords: Upper Paleolithic, Rock art, Archaeological survey, Serbia, Selacka.

Introduction

The emergence of Paleolithic graphic activity is a major milestone in human evolution because it is the first long-term communication system of which we have certainty (because there is a transmitter, a receiver and a message). It also represents a leap in the cognitive evolution as the first evident expression of symbolic thought in History.

In recent years, our understanding of the beginnings of this phenomenon has advanced considerably. Since the 'shock' produced by the first dates for Grotte Chauvet (Clottes et al. 1995), new discoveries and analytical methods have enlarged the repertoire of parietal art in the Early Upper Palaeolithic, to include such sites as Arcy-sur-Cure (Baffier and Girard 1998), Aldène (Ambert et al. 2005), Fumane (Broglio and Dalmeri 2005), Coliboaia (Clottes et al. 2012), Castanet (White et al. 2012), Baume-Latrone (Azéma et al. 2012), Tito Bustillo, Altamira and Castillo (Pike et al. 2012) and recently, Altxerri B (González-Sainz et al. 2013, Ruiz-Redondo 2014).

These evidences indicate that at a very early date (*ca*. 39,000 cal BP), graphic activity was fully developed and spread across a wide area from Germany to the north of the Iberian Peninsula. As these dates are not long after the first *Homo sapiens* reached this area, two alternative hypotheses can be proposed: first, that graphic activity originated outside Western Europe and, second, that our species reached Europe with incipient symbolic activity, which developed rapidly in the new social reality imposed by the colonization of such a large territory.

Technical and symbolic complexity exhibited by these parietal ensembles suggests that the first hypothesis could be more probable than the second one. This may represent a paradigm shift: Paleolithic Art has always been considered as a phenomenon of European origin. If we accept the new paradigm, we have to reverse the path that early anatomically modern humans (AMH) followed to reach Western Europe to seek the 'origin' of Paleolithic graphic activity. The most direct access from the Middle East inevitably passes through the north of the Balkan Peninsula, through the valleys of the Danube and the Sava.

The project that we started in 2012 proposes to carry out a survey of the caves in this area, looking for evidence of ancient Paleolithic Art. Serbian (and other Balkan) karsts have several conditions that point them out as the ideal area to understand the origin of rock art in Europe:

- This is the most likely access road used by early AMH who left the Middle East to colonise Europe.

- There are a great many caves: for example, the Dinaric Alps (the biggest mountain range in Slovenia, Croatia, Bosnia and Herzegovina, Montenegro, Serbia, Albania and Macedonia) are the most extensive limestone mountains in Europe.
- The caverns of that area are virtually unexplored for archaeology. The first archaeological surveys searching for Paleolithic sites began less than 30 years ago.
- In recent years, significant Early Upper Paleolithic (EUP) sites have been discovered in that area.
- Lately, the first evidence of Paleolithic Rock Art in Balkans has come to light: Badanj (Bosnia-Herzegovina) and Coliboaia, if we consider Romania as a part of Balkans. These ensembles are stylistically assigned to the first stages of Upper Paleolithic. Indeed, Coliboaia has direct ^{14}C AMS determinations that confirm that stylistic chronology (Clottes et al. 2012).

We have begun in Serbian caves, but the final goal of this project is to make a selective survey of the walls of all known Upper Paleolithic sites and other caves in Slovenia, Croatia, Bosnia, Serbia, Montenegro and Romania. The main objective, as risky as ambitious, is to ‘seek’ the origins of Paleolithic graphic activity in a place outside the ‘traditional areas’ of distribution of this art. It was an unexplored region in this field until less than 10 years ago (with the exception of Badanj Cave) but also an area that has already begun to show its potential.

Methodology

Fieldwork

The criteria for cave site selection were the following: a) caves with known Upper Paleolithic deposits (based on previous work by D. Mihailovic, S. Kuhn and V. Dimitrijevic in Eastern Serbia); b) caves close to Upper Paleolithic sites, and c) caves documented by T. Dogandzić in Despotovac area. In sum, a total of 29 caverns in different areas of the country have been studied (tab. 1).

Cave	Parietal remains	Cave	Parietal remains
Baranica	Some modern *graffiti*	Monastirska Pecina	-
Baranica 2	-	Suva Pecina	Some modern *graffiti* and red natural ocher deposits
Baranica 3	-	Salitrena Pecina	Torch marks and bear scratches. The walls are covered by red natural ocher
Gabrovnica	Some modern zoomorphic figures and *graffiti*	Vrelska	Torch marks and some modern *graffiti*
Selačka	-	Pecina Malo Vrelo	Many modern *graffiti*
Selačka 2	-	Rakova Pecina	Three engraved straight lines, probably recent
Selačka 3	Red paired marks and some torch marks	Pecina sa Kaminom	-
Milušinačka	Torch marks, red natural ocher depots and five possible red points over a calcite layer	Canina Pecina	A finger fluting that seems to be recent
Prerast	-	Vlaska Pecina	Some modern *graffiti*
Zamna	-	Mala Pecina	-

Zamna 2	-	Pecina Burdelski Potok 4	-
Devojačka	-	Resavska Pecina	Some modern *graffiti*
Druga Kapica	-	Velica Pecina	Some *graffiti*, a yellow painted cross and some red stains, all recent
Druga Kapica 2	-	Busna Pecina	Some *graffiti* and a yellow painted cross and some red lines, all recent
Pecina Bukovac	A possible engraving, but the anthropic origin is not clear		

Table 1. List of studied cave sites with traces of graphic activity.

The methodology applied at the cave sites included the following procedures:

- Survey of the walls, ground and ceiling. Exhaustive and systematic examinations of all cave surfaces within the caves and each of the chambers in search for graphic remains have been undertaken.
- Archeometric documentation. Data gathering was undertaken in situ by visual means either using an x4,8 magnifying glass or by naked eye. To enhance visibility, cold light lamps powered by autonomous batteries (Scurion® 900 and Petzl® Duo Led 14 Accu) were used. Data were recorded and processed with a standardized Filemaker Pro 12® database.
- Graphical documentation. Photographic documentation of the caves entrance, the interior of the cave and the walls, as well as from the parietal and other anthropic remains was taken. Photographs were taken using a digital camera Sony® A-230 with Sony® SAL 18-55 mm f3.5-5.6 DT and Sigma® 70-300 / 4,0-5,6 DG APO Macro lenses as well as an external flash Sony® HVL-F58AM.

Laboratory work

After the fieldwork, much work remained for processing, structuring and analysis of the data generated in the field through the construction of a specifically designed database. In order to analyse the parietal remains found the photographs were subjected to image enhancement using Adobe Photoshop® and ImageJ® (with the Dstrech® plugin). Following this step, digital relevés have been made using the infographic method (Fritz and Tosello 2007) in Adobe Photoshop® and Adobe Illustrator®.

Preliminary results: the case of Selacka 3

Location and archaeological context

The cave of Selačka 3 is situated NE of the city of Knjaževac (Serbia), in the Selačka valley (fig. 1). The cave combines two narrow enclosed chambers with a somewhat more extensive rockshelter in the front (fig. 2).

The deposit was excavated by S. Kuhn and D. Mihailović. They have identified a stratigraphy divided into three major layers (1-3) with a series of sub-layers within each. Their description of the layers and the materials recovered is the following (Kuhn et al. this volume):

Layer 1 consists of dark, organic Holocene sediments containing artefacts dating from the Paleolithic to the modern era. Layer 2 consists of reddish brown clay-rich sediment, disturbed by pits and animal burrows. Two clearly Paleolithic artefacts were collected from this layer. One is a basal fragment of a small, straight bladelet with fine inverse retouch on one margin. The other is a complete bladelet with a distinctly twisted profile. The authors think that these materials are not absolutely culturally diagnostic, but they do fall within the range of variation of Aurignacian *lamelles Dufour*. Finally, layer 3 is clearly a Pleistocene deposit. It consists of yellowish sandy clay, gravelly in places. A total of 17 artefacts were recovered from this layer. They include two very small centripetally worked cores. Both have many typical Levallois features but do not possess classic Levallois morphology. Retouched tools include two sidescrapers, two denticulated pieces and several fragments of retouched pieces. The small faunal assemblage (only ten identifiable specimens) includes only wild species: *Equus ferus, Capra ibex* and *Rupicapra rupicapra*.

The authors provisionally Layer 3 at Selačka 3 to a fairly recent Middle Paleolithic (late MIS 4 or MIS 3). The findings from layer 2 are more ambiguous. However, the presence of two small bladelets, one twisted and one inversely retouched, does suggest that the site possesses an Upper Paleolithic occupation, probably from EUP.

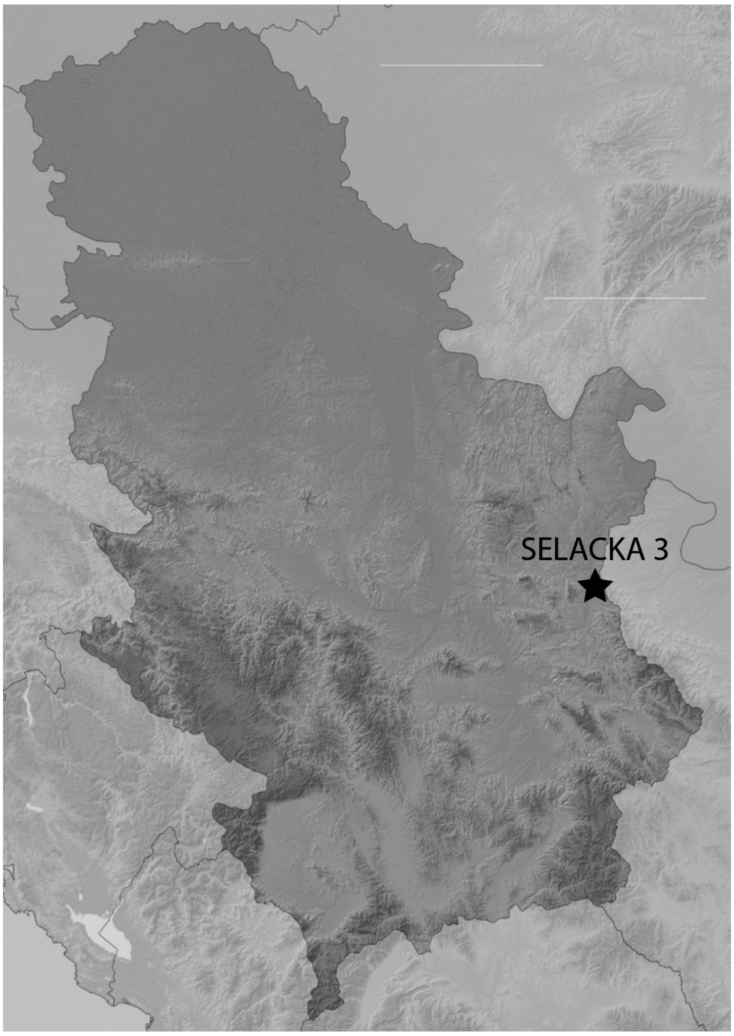

Figure 1. Location of the cave of Selačka 3 in Serbia.

Parietal ensemble

On the 10th of October 2012 the cave was explored together with to B. Ilijic and A. 'Sasha' Milutinovic; the cave walls, ceiling and ground were carefully inspected for parietal remains.

Along different walls of cave some torch marks were found, attesting to previous anthropic explorations inside the cave. Furthermore, some 5 meters away from the main entrance of the cave, on the left wall, other graphic remains were observed. Regardless of its position, in relative proximity to

Figure 2. General view of the rockshelter and the entrance of Selačka 3. The excavation area can also be seen.

the entrance hall, the parietal remains are not hit by sunlight, therefore being in a "half-shade zone" (Pastoors and Weniger 2011).

The graphic remains consist in a series of two small red marks. They are parallel and vertical and have an undeniable anthropic origin (fig. 3). They are the result of the action of dragging two fingers covered by pigment down the wall. The maximum length of the Graphic Unit is 4 cm, the maximum width is 3 cm, and the height from the floor is 149 cm. They couldn't be natural, however, it is possible that they were made in historical times. The possibility of a recent origin, however, is very low, which is to say that it most likely is of Paleolithic age.

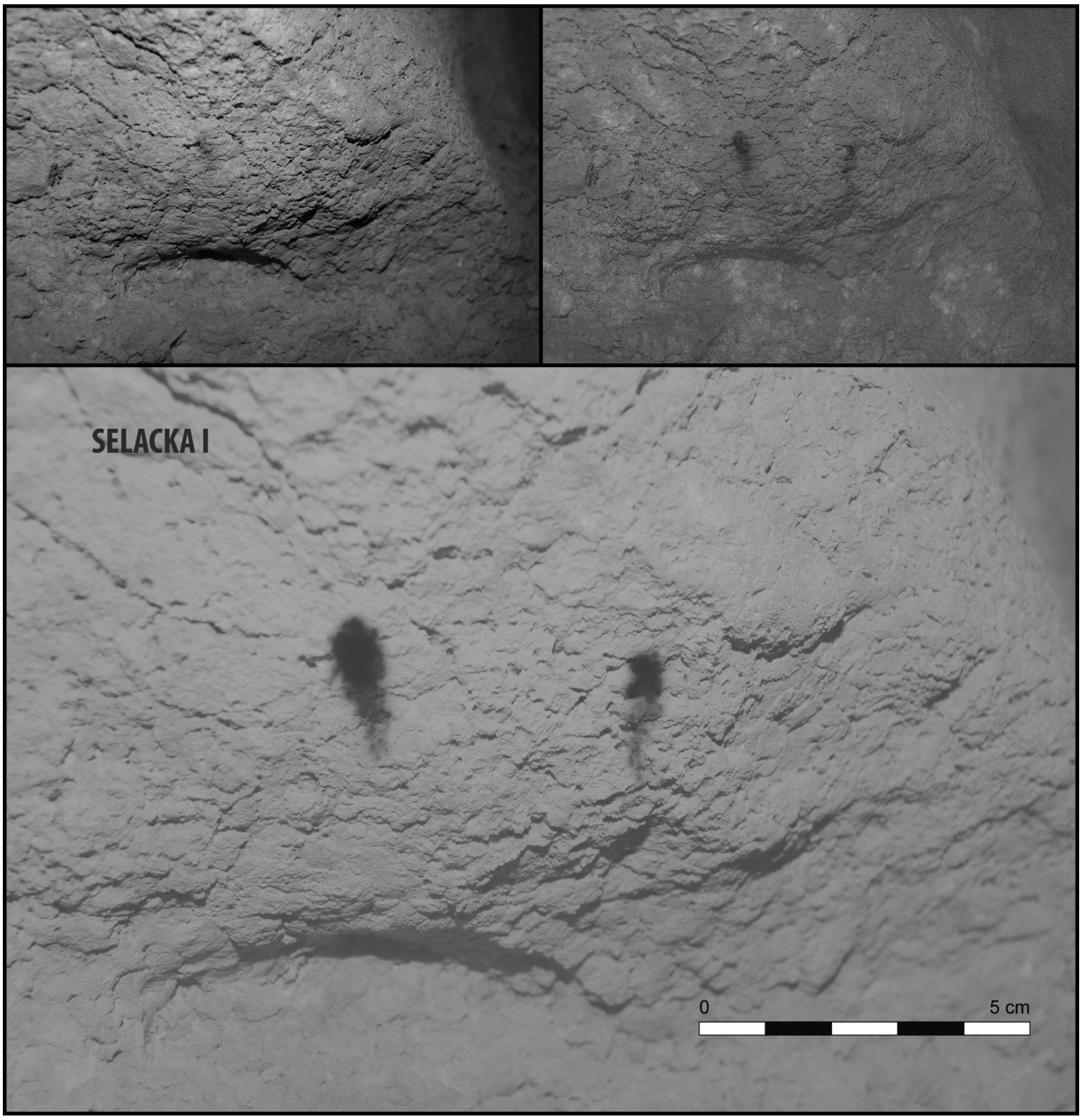

Figure 3. Photograph, photograph enhanced by Dstrech® and relevé of the graphic unit I of Selačka 3, the unit is composed of two short parallel marks (paired marks).

This type of parietal motif is known as "paired marks", as is relatively common among cave sites with Paleolithic art in Spain and France. These signs are frequently found in association with negative hand stencils (e.g. El Castillo, La Garma…) positive hand stencils (e.g. Askondo), series of dots or discs (e.g. El Castillo) and archaic zoomorphic representations (e.g. Chauvet, Altxerri, La Pileta…). This association (in occasions on the same panel) of paired marks and other distinctive Early Upper Paleolithic motifs has been previously documented (González-Sainz 1999). The geographical distribution of this pattern is relatively wide, with known examples found throughout Dordogne in south western France (Abri Blanchard) and the Iberian Peninsula (La Pileta). Although this pattern is rather simple its chronology is broadly restricted to the Aurignacian and Gravettian cultural periods of the Upper Paleolithic (Garate 2010). Occurrences of this pattern that present coherent contextual chronologies and/or direct radiocarbon age determinations cluster between the Aurignacian (*ca*. 39000 cal BP), with its oldest known representation at Altxerri B (González-Sainz et al. 2013, Ruiz-Redondo 2014), to the beginning of the Solutrean (*ca*. 22000 cal BP), as found at La Pileta (Sanchidrián et al. 2001).

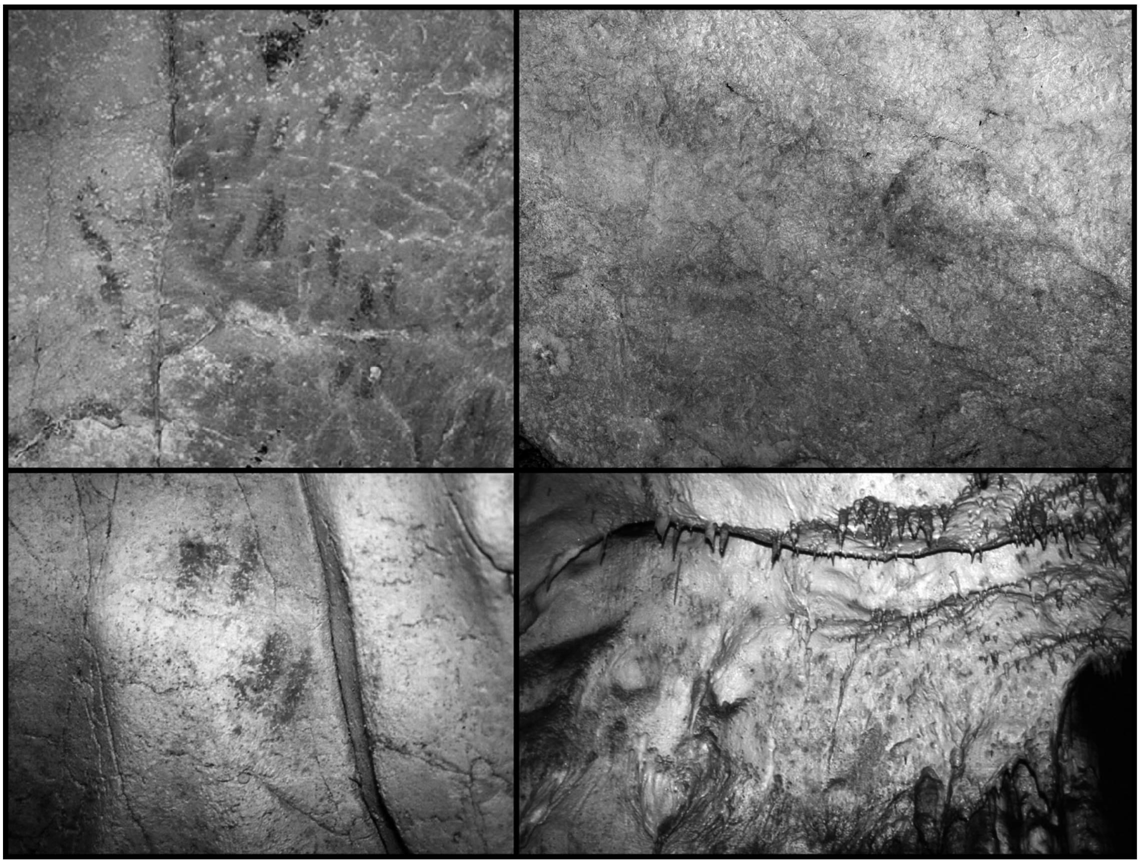

Figure 4. Examples of paired marks in Paleolithic Art. Up left, Astigarraga (Gipuzkoa, Spain); Up right, Askondo (Biscay, Spain); Down left, Chufin (Cantabria, Spain); Down right, Lloseta (Asturies, Spain).

While a secure chronological attribution of the motif at Selacka 3 is impossible at this stage, the following arguments strongly favour an Early Upper Paleolithic origin:

- Although the paired marks are fairly plain in morphology they are well defined motif limited to the Early Upper Paleolithic graphic context.
- The presence of Paleolithic occupational layers in the cave, with some artefacts presenting Early Upper Paleolithic affinities (Kuhn et al. this volume).
- In the explored Serbian caves graffiti from recent periods is much rarer than in South-western European caverns. Furthermore, these are generally painted in black and are of alphabetical character. The paired marks from Selacka 3 are made with natural red ocher, the same colorant used in Paleolithic. This pigment was not found in any other parietal motif of the surveyed sites in Serbia.
- The possibility of an intentional falsification of the motif is very small. The cave is in a region (the Balkans) without known Paleolithic art (except Badanj Cave), therefore, popular knowledge of its graphic representations is limited and restricted to the most famous figures (e.g. bisons from Altamira and bulls from Lascaux).

Therefore, in absence of contradictory evidence, the most probable hypotheses is that the paired marks from Selačka 3 were made at some point during the Upper Paleolithic, probably in its early phase (*ca*. 40000-22000 cal BP).

Conclusion

The Balkan region offers great possibilities for the archaeological study addressing the Paleolithic period. It represents a key access zone connecting the Near East to Central Europe (through the Danube corridor) as well as Southern Europe, through the Adriatic coast. The number of studies aiming at the Paleolithic period in this area has only recently begun to increase. In spite of this fact, the potential of this region has been demonstrated with the discovery of very relevant sites (e.g. Balanica, Šalitrena…). With respect to Paleolithic art, with the exceptions of Badanj Cave (Bosnia-Herzegovina) and Coliboaia (Romania), this vast territory remains *terra incognita*.

Here the first evidence for graphic motifs probably belonging to the Paleolithic period in Serbia have been presented. Although the findings are relatively simple they encourage further rock art surveys in the Balkans. Future studies in this area would greatly widen our understanding of the origins of symbolism in prehistoric societies.

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MESOLITHIC SETTLEMENT IN THE IRON GATES REGION: INTEGRATING CURRENT ARCHAEOLOGICAL AND GEOARCHAEOLOGICAL EVIDENCE

Ivana Radovanović, Rolfe Mandel and Dušan Mihailović

Abstract: This paper presents results from a recent survey of the Mesolithic sites in the flatlands and mountainous hinterlands of the Danube Iron Gates region. Previously explored and currently submerged sites located along the Danube Gorges' riverbanks represent only a fraction of the regional early Holocene hunter-gatherers' settlement network. Based on previous studies of stratified archaeological sites, there appear to be gaps in the record of human occupation during the early and middle Holocene in the region, which has sparked questions about the cause of such chronological discontinuities. Our study included a geoarchaeological assessment of the Holocene and terminal Pleistocene alluvial stratigraphy at a newly recorded site on the Danube River. Results of the investigation allow us to address the temporal and spatial patterns of recorded archaeological sites and consider geomorphic processes that have shaped that record. Our findings also provide a more reliable framework for understanding Mesolithic hunter-gatherer land-use in the Iron Gates region.

Keywords: Mesolithic, Holocene, Iron Gates, paleosols

Introduction

The material culture evidence from the late Pleistocene and early Holocene Danube riverbank sites indicates a variety of Mesolithic hunter-gatherer adaptive strategies, including the use of the same locations for residential and/or aggregation camps that preceded the first contact with food producers in this part of the Balkans by at least four millennia. The decades long archaeological debates remained focused on the Final Mesolithic (6300-5900 calBC) - a few hundred years of the local hunter-gatherers' interaction with the incoming food producers – an important part of the European neolithization "grand narrative" (Srejović 1972, Jovanović 1974; Voytek and Tringham 1989; Hodder 1990; Bailey 2000; Chapman 2000; Tringham 2000; Garašanin and Radovanović 2001; Zvelebil 2001; Whittle 2003; Fiedel and Anthony 2003; Borić 2007; Radovanović 1996a, 2006; Bonsall et al. 2004, 2008).

Our recent geoarchaeological and archaeological survey of Mesolithic sites in tandem with building a finer resolution record of the local late Pleistocene and Holocene climate oscillations (AMS dating and stable carbon isotope analyses) had an aim to learn more about the scope of local Mesolithic settlement in the Iron Gates hinterlands beyond the Danube Gorges space, and preceding the Final Mesolithic time. Evidence from our targeted survey and test excavations accomplished in the initial phase of research in 2011 and 2012 (collected artifacts and ecofacts and determined SOM radiocarbon ages) indicated that an expectation of the late Pleistocene and early Holocene settlement in this area downstream from the Danube Iron Gates gorges is plausible. Recent research in the Balkans will certainly help place this local palaeoenvironmental and archaeological record in the broader regional framework (Bordon et al. 2009; Aufgebaurer et al. 2012; Feuerdean et al. 2012; Filipova-Marinova et al. 2013; Heymann et al. 2013; Panagiotopoulos et al. 2013).

The known Iron Gates Mesolithic sites are dated between 13,200 and 5,900 cal BC, but a more precise chronological correspondence among these sites that should be based on the ages of their establishment, use, abandonment and re-settling, i.e., the question of their actual contemporaneity, is still needed in order to reconstruct the Iron Gates Mesolithic hunter-gatherer land-use and mobility. These sites are submerged, so new materials cannot be collected from them. However, a series of AMS ages determined on human bones collected at these sites between the mid-1960s and 1980s clarified some of the chronostratigraphic questions, but mainly for the Final Mesolithic, while the Early and Late Mesolithic archaeological phases that do reflect important cultural changes remained lumped within excessively broad, millennial-scale time spans. The new information from our 2011-12 survey (Bogdanova cave, Sokolovica alluvial fan, and two previously unexplored rivebank sites near Radujevac; Fig. 1- 25, 26, 27) represents a first step toward establishing chronological correspondence between the existing data from previous riverine sites' research and the new data from the inland and downstream Mesolithic site locations.

Background

The Iron Gates Mesolithic riverbank sites (Fig. 1 – no.1-24) were first recorded along 170 kilometers of the Danube banks and explored in the course of two archaeological rescue excavation projects in 1966-1970 and 1980-1986, before they were submerged under the reservoirs formed after the construction of hydroelectric plants on the Danube. Because water levels rose

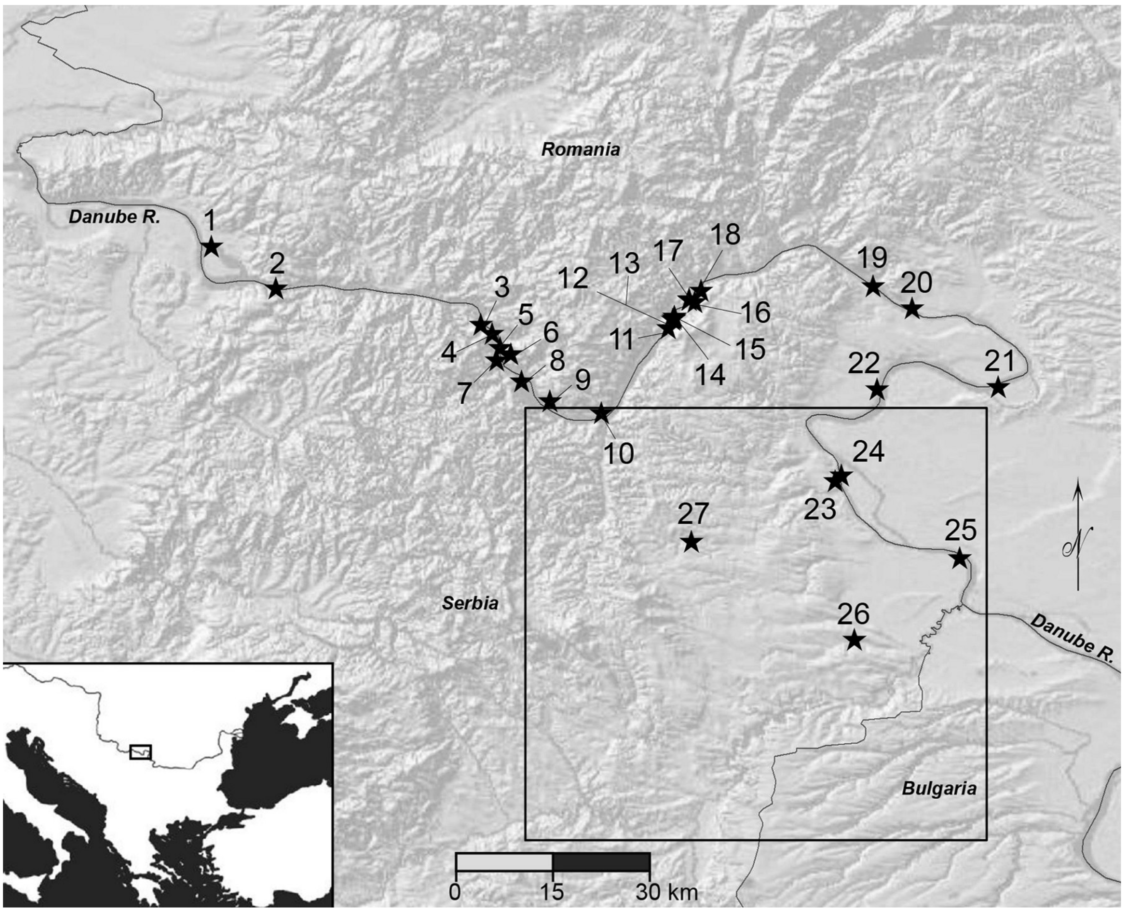

Figure 1. Iron Gates region with location of Mesolithic sites recorded in 1966-1970 (1-21); 1980-1986 (22-24); 2011-2012 (25-27). Current study area is outlined. 1-Moldova Veche; 2-Alibeg; 3-Padina; 4-Stubica; 5-Iliova; 6-Izlaz; 7-Lepenski Vir; 8-Vlasac; 9-Svinita; 10-Virtop; 11-Cuina Turcului; 12-Climente I; 13-Climente II; 14-Veterani Cave; 15-Veterani Terrace; 16- Hajdučka Vodenica; 17-Icoana; 18-Razvrata; 19-Ostrovu Banului; 20-Schela Cladovei; 21-Ostrovu Corbului; 22-Velesnica; 23-Kula; 24 Ostrovu Mare; 25-Radujevac WP155; 26-Sokolovica; 27-Bogdanova.

quickly in the reservoirs, some of the sites could only be recorded or excavated on a small scale, and a few were more systematically explored. Limited portions of the now submerged sites, such as Schela Cladovei and Vlasac, which remained accessible in the aftermath of reservoir construction, were excavated during the 1990s and in the mid 2000s.

This previous research of the Iron Gates Mesolithic allowed distinguishing several archaeological phases: Early Mesolithic 13,200-7,200 cal BC, Late Mesolithic 7,200-6,300 cal BC, and the period of the Final Mesolithic or Meso/Neolithic transition 6300-5900 cal BC (Radovanović 1996, 2000; Bonsall 2008). The Early Mesolithic includes material culture in the caves, rockshelters, and open-air sites both in the gorges and on the Danube banks and islands. While the late Pleistocene sites in the Iron Gates Gorges' caves and rockshelters reflect a broad- spectrum economy (Cuina Turcului, Climente II), the early Holocene open-air camps at Padina, Vlasac, and Schela Cladovei point to a major change toward intensified fishing. The establishment and long-term use of these and other locations along the Danube banks for fishing continues throughout the Early Mesolithic along with establishing permanent structures and formal disposal areas for a growing number of burials marked by a variety of elaborate, often site-specific, funerary procedures. Local cherts and quartzes, with a small proportion of the better quality non-local raw materials, were used for production of chipped stone artifacts in the technological tradition of the southeast European Tardigravettian technocomplex.

In the Late Mesolithic, chipped stone industries are marked by the appearance of geometric microliths and a much higher proportion of local quartz in comparison to the previous phase. Other portable archaeological material, such as (sometimes decorated) bone, antler, and boar's tusk artifacts, were found in large quantities at all of these stratified sites. Apart from fish, faunal remains are dominated by red deer, a respective higher proportion of wild cattle in the Upper Gorges, and wild pig in the Lower Gorges toward the end of the Late Mesolithic. Appearance of dogs, the only domesticated species, is also noted at the open-air sites since the Early Mesolithic.

The subsequent Final Mesolithic is marked by a new important shift in hunter-gatherer subsistence strategies from intensive fishing to the inclusion of a higher proportion of terrestrial food sources by 6300 cal BC. Palaeodietary analyses of stable C/N isotopes in human bones confirmed this change toward a broad-spectrum diet. This change additionally coincides with the establishment of dwelling and ceremonial structures at Lepenski Vir, with ornamented sculptures embedded in these structures' floors, along with a variety of other symbolic artifacts, and new mortuary practices differing in many details from those in the Early and Late Mesolithic. These structures also contained pottery and other artifacts of the local Early Neolithic provenience. The collected human and faunal remains from Lepenski Vir and other Iron Gates Mesolithic sites allowed additional analysis in 1990s and 2000s (Bonsall et al. 1997; Borić and Miracle 2004; Bonsall et al. 2008), especially through the application of improved methods of dating and bone chemistry analyses. Unfortunately, and more often than not, their validity is undermined by uncertainty of provenance (imprecise initial field observations of site stratigraphies, disregard of palimpsests), and subsequent misinterpretations of the record at many of these sites marked by outstandingly complex formation histories.

Archaeology

Our study area envelops a portion of the Carpathian-Balkan mountainous stretch between the Wallachian and Pannonian basin, with a mosaic of diversified resources ranging from the forest and mountainous to the steppe, wetland, and riparian. The accessibility of several ecological niches associated with different altitudes of the terrain (from 30 m to 2000 m above sea level) in the noted area may have offered yet another set of resources at different times of the year (Mišić 1981; Cvijić 1987; Radovanović 1996; Kozłowski 1999). The extensive hydrographic network in the drainage basins of the Danube and its tributaries further contributes to the hunter-gatherer settlement potential of that area. Also, the topographic elements include a large number of caves and rockshelters in the karstic formations of the Negotinska peneplane, Deli Jovan, Veliki Greben, and Miroč mountains that were suitable for hunter-gatherers' seasonal and special-purpose camps within a relatively easy reach to and from the Mesolithic riparian sites.

The above described abundant archaeological evidence from the riparian Mesolithic sites indicated important fluctuations between the broad-spectrum and the aquatic based hunter-gatherer economy between 13,000 cal BC and 5,900 cal BC, including variable acquisition of the local and non-local raw material resources (Radovanović 1996; Mihailović 2008). Consequently, these settlements could not represent an independent and self-sufficient riverine adaptation in any of their Mesolithic phases. It is therefore reasonable to assume that areas neighboring the Iron Gates provided an important supply of raw material, game, and plant resources, and to expect additional archaeological evidence of the Mesolithic seasonal, transient, special purpose camps and extraction sites in these areas.

Five narrowly delineated target areas in this study area were chosen for exploration in 2011-12 and sites in three of them continued to be explored in subsequent years. In this paper we focus on the results obtained from one of them, the Danube riverbank between Prahovo and Radujevac (Fig 1 No. 25).

Potential Mesolithic sites along the Danube riverbank in this target area were expected at approximately 3 m below ground surface, based on the assumption that they match the depth of the Mesolithic deposit at the presently submerged site of Kula 20 km upstream (Radovanović 1996; and here Fig. 1 -23). The river profiles were accessible for exploration during 2011 field research at even greater depth, because the Danube water level was unusually low. In 2012, however, the banks were not accessible due to high waters. During the 2011 survey, backhoe trenches were established at 50 m intervals along the riverbank profile exposing the deposits. All sediments were water screened with 2 mm sieves. Upper portions of these deposits contained mostly Late Roman and Iron Age pottery. The Final Mesolithic/Early Neolithic chipped stone artifacts (diagnostic thumbnail scraper in local brown jasper and numerous yellow-white spotted "Pre-Balkan platform" flint blades and a core) were collected on the beach surface 5-10 m away from these profiles, on three locations between Radujevac and Prahovo, and at another one south of Radujevac (Fig. 1 No. 25; Fig. 2 sections 1

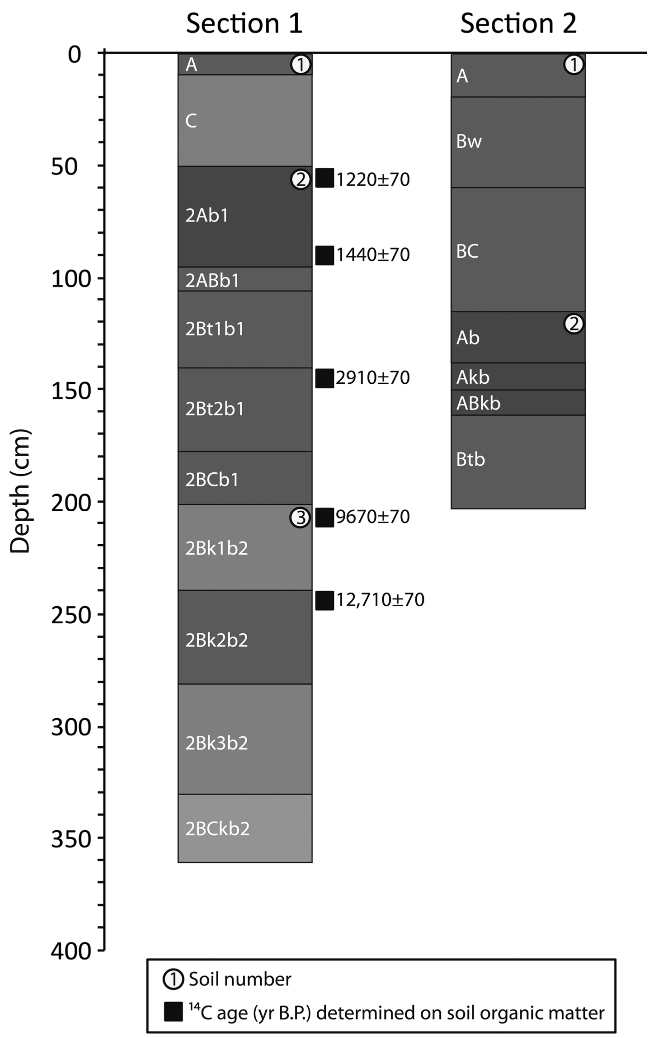

Figure 2. Section 1 (WP 155) and Section 2 (WP 154) at the Danube bank near Radujevac.

and 2, Fig. 3). An attempt was made to collect sediment samples at these beach locations, but the sediment above the level where the artifacts were recorded was heavily waterlogged and did not allow further exploration.

Soil organic matter (SOM) samples from one Danube section in this target area (Fig. 1 No. 25 and Fig. 2 – Section 1) were collected in 2011 at Waypoint 155 (Laguna locality) north of Radujevac. The SOM radiocarbon ages point to a significant chronological hiatus in this particular riverbank section. Specifically, while buried soils dating to the late Pleistocene and the beginning of the early Holocene (soil 3 after R. Mandel's geomorphological investigation described below) are preserved (samples ISGS 6987 and 6988), significant stream erosion must have occurred after the beginning of the ninth and before the mid second millennium calBC (OxCal v4.2.2. Bronk Ramsey 2013).

Results of stable carbon isotope analyses of these soil samples, important for reconstructing bioclimatic change during the late Pleistocene and early/mid-Holocene, are pending.

Geomorphology

The primary goal of this investigation was to determine the soil stratigraphy and geochronology of alluvial fills in Danube River valley. This information was in turn used to assess the geologic potential for buried archaeological deposits.

Methods

The geomorphological investigation initially involved reconnaissance of Danube River valley. Cutbank exposures were inspected along the west bank of the Danube in order to gain an understanding of the alluvial stratigraphy of the river.

The next phase of the field investigation involved soil-stratigraphic studies at two localities: Waypoint 155 (Laguna locality) immediately north of Radujevac, and Waypoint 154 immediately south of Radujevac (Figure 1- No. 25) Cutbank exposures were cleaned off with a hand shovel and described using standard procedures and terminology outlined by Birkeland (1999) and Schoeneberger et al. (2002). However, when multiple buried soils were present, the horizon nomenclature presented by Holliday (2004: 339) was used. Specifically, the buried soils were numbered consecutively from the top of a section downward, with the number following the suffix "b." For example, the A horizons of three superposed buried soils would be numbered Ab1, Ab2, and Ab3 from top to bottom. Carbonate morphology was defined according to Birkeland's (1999) classification scheme.

Soils were included in the stratigraphic framework of every profile that was described. Soils are important to the subdivision of Quaternary sediments, whether the soils are at the present-day land surface or buried (Birkeland 1999). After soils were identified and described, they were numbered consecutively, beginning with 1, the modern surface soil, at the top of the profile. Graphic profiles were constructed to visually convey soil-stratigraphic information for most of the sections.

Bulk soil samples were submitted to the Illinois State Geological Survey (ISGS) Isotope Laboratory for radiocarbon dating. The samples were decalcified and the soil organic matter (SOM) was assayed at the ISGS Isotope Laboratory by conventional radiocarbon-dating methods. The radiocarbon ages are reported in uncalibrated years before present (^{14}C yr B.P.). All radiocarbon ages were corrected for isotopic fractionation.

Although radiocarbon dating of soil can be problematic (Birkeland 1999; Martin and Johnson 1995; Holliday 2004:178-183), with proper care in sampling and interpretation, SOM can provide accurate age control, especially in drier environments where there is evidence of secondary accumulation of calcium carbonate (Holliday et al. 2006). Radiocarbon ages determined on SOM represent mean residence time for all organic carbon in the sample (Campbell et al. 1967).

Although mean residence time does not provide the absolute age of a buried soil, it often gives a minimum age for the period of soil development, and usually provides a limiting age on the overlying material (Scharpenseel 1971; Geyh et al. 1975; Haas et al.,1986; Birkeland 1999:138).

Results of investigations

Section 1, Waypoint 155

At Waypoint 155, also referred to as the Laguna Locality, the Danube River has migrated laterally into valley fill underlying a broad alluvial terrace that dominates the valley floor. The terrace surface is about 6 m above the surface of the modern floodplain. A thick section of fine-grained alluvium is exposed in a cutbank (Figure 2), and Mesolithic artifacts were found on the ground near the foot of the cutbank. The cutbank was cleaned off with hand shovels, described, and sampled for radiocarbon dating.

At the Laguna Locality, a surface soil and two buried soils are developed in the upper 3.7 m of the terrace fill (Figure 3). The top stratum is a 50 cm-thick eolian mantle consisting of loamy fine sand. The modern surface soil (Soil 1) developed in this mantle has a weakly expressed A-C profile (Figure 3 and Table 1). The A horizon is only 10 cm thick; hence Soil 1 probably represents less than 100 years of pedogenesis. An abrupt boundary separates the C horizon of Soil 1 from the A horizon of Soil 2.

Soil 2 is a depth of 50-202 cm and has a well-expressed A-AB-Bt-BC profile developed in alluvium. The 2Ab1 horizon is 45 cm thick and consists of dark grayish brown (10YR 4/2, dry) very fine sandy loam. A few well-rounded pebbles are scattered through the matrix of this horizon as well as the other horizons comprising Soil 2. The 2Bt1b1 and 2Bt2b1 horizons have a combined thickness of 72 cm and consist of yellowish brown (10YR 5/4 and 5/8, respectively, dry) very fine sandy loam. The Bt horizons of Soil 2 have moderate, medium, prismatic structure parting to moderate, fine, subangular blocky structure, and distinct, discontinuous dark grayish brown (10YR 4/2, dry) clay films occur on ped faces and in macro-pores. Chipped-stone artifacts were recovered from the 2Bt2b1 horizon of Soil 2 when the section was prepared for description. The 2BCb1 horizon consists of yellowish brown (10YR 5/6, dry) fine sandy loam. An abrupt, wavy boundary separates the 2BCb1 horizon from Soil 3.

Soil 3 is at least 160 cm thick and has a well expressed Bk-BCk profile; the A horizon was stripped off by stream erosion before the soil was buried. The 2Bk1b2 and 2Bk2b2 horizons consist of light yellowish brown (2.5Y 6/4, dry) sandy loam and light olive brown (2.5Y 5/4, dry) sandy loam, respectively. Stage II carbonate morphology occurs in both of these horizons, and secondary carbonate accumulations include fine, hard rhizoliths. The 2Bk3b2 consists of light yellowish brown (2.5Y 6/4, dry) loamy fine sand with stage II carbonate morphology that includes rhizoliths. Pale yellow (2.5Y 7/4, dry) loamy fine sand comprises the lower 30 cm of the profile (2BCkb2), and the alluvium coarsens downward.

The history of Holocene landscape evolution at the Laguna Locality is inferred from a suite of five radiocarbon ages determined on soil organic matter (SOM). A radiocarbon age of 12,710±70 yr B.P. determined on SOM from the upper 10 cm of the 2Bk2b2 horizon indicates that aggradation of the terrace fill slowed and development of Soil 3 was underway by at least ca. 12,700 B.P. Soil development continued into the early Holocene, as indicated by a radiocarbon age of 9670±70 yr B.P. determined on SOM from the upper 10 cm of the 2Bk1b2 horizon. Soil 3 was truncated and buried after ca. 9600 B.P. SOM from the upper 10 cm of the 2Bt2b1 horizon of Soil 2 yielded a radiocarbon age of 2910±70 yr B.P. Hence there is a significant unconformity between soils 3 and 2, i.e., most of the early Holocene and all of the middle Holocene record is missing in this stratigraphic section. It is likely that the erosion event(s) that truncated Soil 3 removed that record. However, aggradation was underway again soon before ca. 2900 B.P. SOM from the upper and lower 10 cm of the 2Ab1 horizon of Soil 2 yielded radiocarbon ages of 1220±70 and

1440±70 yr B.P., respectively. Based on these ages, Soil 2 continued to develop through the late Holocene and was buried sometime after ca. 1200 B.P. The numerical age of the eolian mantle is unknown, but the modern surface soil (Soil 1) probably is less than 100 years old.

Based on the radiocarbon chronology described above, Soil 3 represents a deeply buried Mesolithic-age landscape. The Mesolithic artifacts found near the foot of the cutbank probably eroded out of Soil 3. It is likely that this buried soil occurs beneath the entire width of the terrace; hence there is high geologic potential for buried Mesolithic cultural materials beneath most of the valley floor in the area of Radujevac.

Because of one or more erosion events, alluvium dating between ca. 9600 and 2900 B.P. is missing in the stratigraphic section. Hence there is no potential for cultural deposits dating to that period. However, a thick package of late-Holocene alluvium is preserved in the section, and chipped-stone artifacts recorded in the 2Bt2b1 horizon of Soil 2 probably are Early Iron Age materials. Cultural deposits dating from the Iron Age through the Roman period may occur within Soil 2, and younger cultural deposits, including Byzantine materials, may occur on the buried surface of Soil 2.

Section 2, Waypoint 154

At Waypoint 154, the Danube River has migrated laterally into valley fill underlying an alluvial terrace with a surface about 3-4 m above the surface of the modern floodplain. A 2 m-thick section of fine-grained alluvium was exposed in an archaeological test unit that was excavated into the scarp separating the terrace from the floodplain. The east-facing wall of the test unit was described (Table 2).

Two strata comprise the upper 2 m of the terrace fill at Waypoint 154. The top stratum is 117 cm thick and has been modified by pedogenesis. The surface soil (Soil 1) in the top stratum has a moderately expressed A-Bw-BC profile developed in an upward-finig sequence. The A horizon is 21 cm thick and consists of grayish brown (10YR 5/2, dry) heavy silt loam to light silty clay loam. Many biogenic features occur in the A horizon, indicating intensive bioturbation. The cambic (Bw) horizon is 39 cm thick and consists of brown (10YR 5/3, dry) silt loam. Weak, fine, subangular blocky structure occurs in the Bw horizon; there is no evidence of secondary clay or calcium carbonate accumulation. The BC horizon consists of brown (10YR 5/3, dry) very fine sandy loam. A clear, smooth boundary separates the BC horizon from the A horizon of a soil (Soil 2) developed in the bottom stratum.

Soil 2 is at least 83 cm thick and has a well-expressed A-Ak-ABk-Bt profile. The Ab and Akb horizons have a combined thickness of 33 cm and consist of dark grayish brown (10YR 4/2, dry) silt loam. Stage I carbonate morphology occurs in the Akb horizon, and increases to stage I+ in the BCkb horizon. The Btb horizon consists of yellowish brown (10YR 5/4, dry) to brown (10YR 5/3, dty) very fine sandy loam and has weak, fine, subangular blocky structure. Common, distinct, discontinuous, dark grayish brown (10YR 4/2, dry) clay films on ped faces in the Btb horizon.

The numerical age of the terrace fill exposed in Section 2 is unknown. However, based on landscape position, soil evidence, and the radiocarbon ages determined on soil organic matter from buried soils beneath the higher terrace at the Laguna Locality, all of the alluvium in Section 2 probably aggraded after ca. 3000 B.P. Hence, Iron Age and younger cultural deposits may occur in buried contexts at this locality.

Table 1. Description of Section 1.

Landform: Alluvial terrace
Slope: 1%
Drainage class: Well drained
Land Cover: Native grass
Remarks: Chipped-stone artifacts were recovered from the 2Bt2b1 horizon of Soil 2 when the section was prepared for description. Soil organic matter (SOM) from the upper and lower 10 cm of the 2Ab1 horizon of Soil 2 yielded radiocarbon ages of 1220±70 yr B.P. (ISGS-6984) and 1440±70 yr B.P. (ISGS-6985), respectively. SOM from the upper 10 cm of the 2Bt2b1 horizon of Soil 2 yielded a radiocarbon age of 2910±70 yr B.P. (ISGS-6986). SOM from the upper 10 cm of the 2Bk1b2 horizon of Soil 3 yielded a radiocarbon age of 9670±70 yr B.P. (ISGS-6987). SOM from the upper 10 cm of the 2Bk2b2 horizon of Soil 3 yielded a radiocarbon age of 12,710±70 yr B.P. (ISGS-6988)

Depth (cm)	Soil Horizon	Description
		EOLIAN SAND
		Soil 1
0-10	A	Grayish brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; weak fine granular structure; very friable; many fine and very fine roots; common worm casts and open worm burrows; gradual smooth boundary.
10-50	C	Pale brown (10YR 6/2) loamy fine sand, brown (10YR 5/3) moist; massive parting to single grain; soft, very friable; many fine and very fine roots; common worm casts and open worm burrows; abrupt irregular boundary.
		ALLUVIUM
		Soil 2
50-95	2Ab1	Dark grayish brown (10YR 4/2) very fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; very friable; few well-rounded pebbles scattered through the matrix; common fine and very fine and few medium roots; many worm casts and open worm and insect burrows; common fine and very fine pores; gradual smooth boundary.
95-105	2ABb1	Grayish brown (10YR 5/2) very fine sandy loam, dark grayish brown (10YR 4/2) moist; weak fine subangular blocky structure; friable; few well-rounded pebbles scattered through the matrix; common fine and very fine and few medium roots; many worm casts and open worm and insect burrows; common fine and very fine pores; gradual smooth boundary.
105-140	2Bt1b1	Yellowish brown (10YR 5/4) very fine sandy loam, dark yellowish brown (10YR 4/4) moist; moderate medium prismatic structure parting to moderate fine subangular blocky; friable; common distinct discontinuous dark grayish brown (10YR 4/2) clay films on ped faces and in macro-pores; few well-rounded pebbles scattered through the matrix; common fine and very fine and few medium roots; few worm casts and open worm and insect burrows; few krotovina 6-8 cm in diameter filled with dark grayish brown (10YR 4/2) very fine sandy loam; common fine and very fine and few medium and coarse pores; gradual smooth boundary.
140-177	2Bt2b1	Yellowish brown (10YR 5/8) very fine sandy loam, dark yellowish brown (10YR 4/6) moist; weak medium prismatic structure parting to weak fine subangular blocky; friable; common distinct discontinuous dark grayish brown (10YR 4/2) clay films on ped faces and in macro-pores; few well-rounded pebbles scattered through the matrix; common fine and very fine and few medium roots; few worm casts and open worm and insect burrows; few krotovina 6-8 cm in diameter filled with dark grayish brown (10YR 4/2) very fine sandy loam; common fine and very fine and few medium and coarse pores; gradual smooth boundary.
177-202	2BCb1	Yellowish brown (10YR 5/6) fine sandy loam, dark yellowish brown (10YR 4/6) moist; weak fine subangular blocky structure; friable; few well-rounded pebbles scattered through the matrix; common fine and very fine and few medium roots; few worm casts and open worm and insect burrows; many fine and very fine pores; abrupt wavy boundary.
		Soil 3
202-240	2Bk1b2	Light yellowish brown (2.5Y 6/4) sandy loam, light olive brown (2.5Y 5/4) moist; weak medium and coarse prismatic structure parting to weak fine subangular blocky; friable; many fine films and threads of calcium carbonate; few fine hard calcium carbonate rhizoliths; few well-rounded pebbles scattered through the matrix; common granules; few fine and very fine roots; common fine and very fine pores; gradual smooth boundary.

240-282	2Bk2b2	Light olive brown (2.5Y 5/4) sandy loam, olive brown (2.5Y 4/4) moist; weak medium and coarse prismatic structure parting to weak fine subangular blocky; friable; many fine films and threads of calcium carbonate; few fine hard calcium carbonate rhizoliths; few well-rounded pebbles scattered through the matrix; common granules; few fine and very fine roots; common fine and very fine pores; gradual smooth boundary.
282-332	2Bk3b2	Light yellowish brown (2.5Y 6/4) loamy fine sand, light olive brown (2.5Y 5/4) moist; weak medium and coarse prismatic structure parting to weak fine subangular blocky; friable; many fine films and threads of calcium carbonate; few fine hard calcium carbonate rhizoliths; few well-rounded pebbles scattered through the matrix; common granules; few fine and very fine roots; common fine and very fine pores; gradual smooth boundary.
332-362	2BCkb2	Pale yellow (2.5Y 7/4) loamy fine sand, light olive brown (2.5Y 5/4) moist; very weak fine subangular blocky structure; very friable; coarsens downward; common fine threads of calcium carbonate; few fine hard calcium carbonate rhizoliths; common well-rounded pebbles scattered through the matrix; common granules; few fine and very fine roots; many fine and very fine pores.

Table 2. Description of the Section 2, Waypoint 154.

Landform: Alluvial terrace
Slope: 1%
Drainage class: Well drained
Land Cover: Riparian forest

Depth (cm)	Soil Horizon	Description
		ALLUVIUM
		Soil 1
0-21	A	Grayish brown (10YR 5/2) heavy silt loam to light silty clay loam, dark grayish brown (10YR 4/2) moist; moderate medium granular structure; friable; many fine and very fine and few medium and coarse roots; many worm casts and open worm and insect burrows; clear smooth boundary.
21-60	Bw	Brown (10YR 5/3) silt loam, brown (10YR 4/3) moist; weak fine subangular blocky structure; friable; common very fine, fine and medium and few coarse roots; few worm casts and open worm and insect burrows; gradual smooth boundary.
60-117	BC	Brown (10YR 5/3) very fine sandy loam, brown (10YR 4/3) moist; very weak fine subangular blocky structure; friable; common very fine, fine and medium and few coarse roots; few worm casts and open worm and insect burrows; clear smooth boundary.
		Soil 2
117-137	Ab	Dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure parting to moderate medium granular; friable; very few fine flecks of calcium carbonate; common very fine, fine and medium and few coarse roots; few worm casts and open worm and insect burrows; gradual smooth boundary.
137-150	Akb	Dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure parting to moderate medium granular; friable; common fine films and threads of calcium carbonate; common very fine, fine and medium and few coarse roots; few worm casts and open worm and insect burrows; gradual smooth boundary.
150-162	ABkb	Dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; common fine faint yellowish brown (10YR 5/4) mottles; weak fine subangular blocky structure; friable; many fine films and threads of calcium carbonate; common very fine, fine and medium and few coarse roots; few worm casts and open worm and insect burrows; gradual smooth boundary.
162-200+	Btb	Yellowish brown (10YR 5/4) to brown (10YR 5/3) very fine sandy loam, dark yellowish brown (10YR 4/4) to brown (10YR 4/3) moist; weak fine subangular blocky structure; friable; common distinct discontinuous dark grayish brown (10YR 4/2) clay films on ped faces; common very fine, fine and medium and few coarse roots; few worm casts and open worm and insect burrows; many fine and medium pores.

Discussion and conclusion

An indication of several thousand years long stratigraphic hiatus in the portions of the Danube bank section to the north and south of Radujevac does not necessarily indicate a hiatus in human settlement of this area. Lithic artifacts were collected at several localities (WP 154 to the south and WP 155 "Laguna" and "Sidrište" to the north of Radujevac, among others). The collected artifacts are diagnostic for the Late and Final Mesolithic and Early Neolithic of the Iron Gates region. The raw materials used include the Balkan yellow/white-spotted flint for large retouched blades (some with 'sickle polish' Fig. 3, a), circular end-scraper (Fig. 3, f), splintered pieces (Fig. 3 d) and multi-directional flake cores. Micro-blade blanks of grey semi-transparent chalcedony (Fig. 3, b) were also recorded, while a grey chert splintered piece (Fig. 3 c) and a dark brown jasper thumb-nail scraper (Fig. 3 e) are diagnostic for the Late Mesolithic of the region. It is significant to note that all of these artifacts were collected from an exposed (surface) area of the Danube bank, and that there was a complete lack of water-wear on any of them. This may be an indication that they were recently eroded from a layer atop the remaining Soil 3 deposit (which has been truncated by erosion after 9670±70 calBC), and re-deposited at the Danube bank which stood at 1.5 meters below Soil 3 at the time of excavation of Section 1 in 2011. It however was under water upon our subsequent survey in 2012. A lack of the corresponding Late and Final Mesolithic/Early Neolithic material *in situ* above Soil 3 in Sections 1 and 2 probably reflects a fact that a substantial river erosion have already destroyed the bulk of the Late and Final Mesolithic/Early Neolithic occupation areas. What remained from the Late and Final Mesolithic/Early Neolithic was the above described re-deposited material on the Danube bank. The top of the remaining part of Soil 3 is dated in 9670±70 calBC, while its lower part of at 12710±70 calBC (both at 68.2% probability) corresponding entirely to the Early Mesolithic.

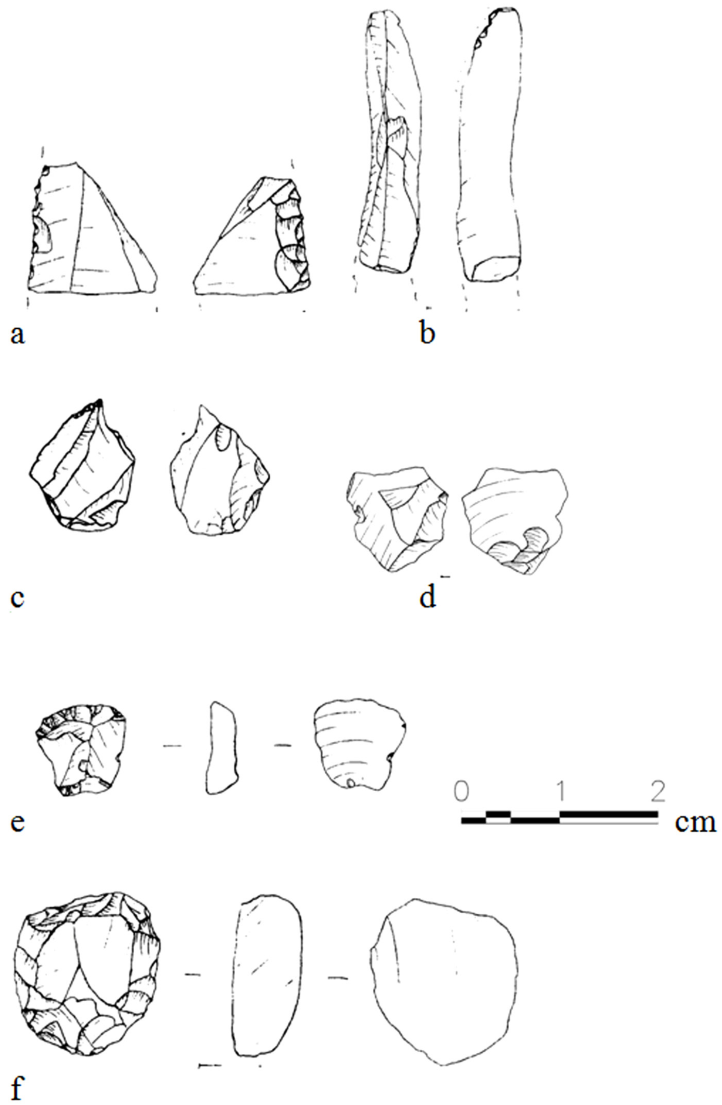

Figure 3. "Laguna" and "Sidrište" locality north of Radujevac – blades a,b; splintered pieces c,d; thumbnail scraper e; circular scraper f.

It therefore can be expected that the remains of the Early Mesolithic human occupation (pre 10th millennium calBC) of the Danube banks and hinterlands downstream from the Iron Gates Gorges are still preserved - the potential sites' location seems to closely correspond to that of the site of Kula/Mihajlovac excavated in the early 1980s (Radovanović 1996). In contrast to these, the later Mesolithic and Early Neolithic sites are expected to have rather patchy distribution and preservation due to major erosive processes affecting this area between the end of the 9th and the beginning of 3rd millennium calBC. These processes and their effect on the Mesolithic settlement remain to be explored in the upcoming years.

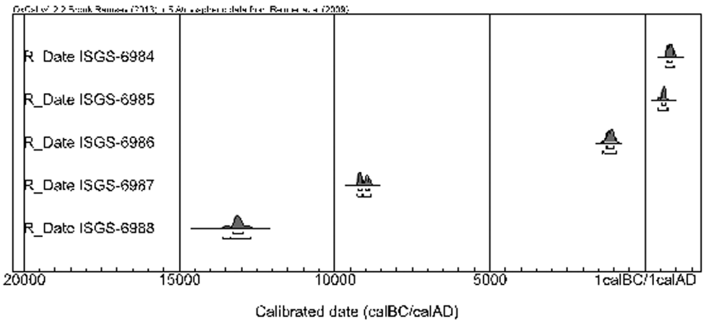

Figure 4. Radiocarbon dates from Section 1 WP 155 – “Laguna” locality north of Radujevac

Notes

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PRELIMINARY REPORT ON THE EXCAVATIONS IN SEOCKA PEĆINA, MONTENEGRO (SEPTEMBER 2013)

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Abstract: This paper presents the results of excavations conducted in Sept. 2013 in Seocka pećina, in the near vicinity of the Skadar Lake. A Mesolithic level, dated by radiocarbon to the late 9^{th} – early 8^{th} millennium cal. BC was discovered, in addition to several finds belonging to the Bronze Age. Although spatially limited, these results are important as they provide a first glimpse of the Mesolithic settlement pattern and associated activities in this under-investigated part of Montenegro.

Key words: Seocka pećina, Skadar Lake, Montenegro, Mesolithic

Introduction

This short contribution reports the first archaeological activities conducted as part of the EUROFARM project on the territory of Montenegro. The five-year project 'Transmission of innovations: comparison and modelling of early farming and associated technologies in Europe' (EUROFARM) investigates the introduction of early farming practices in the western Balkans through a combination of literature survey, access to museum collections and archaeological fieldwork. One of its main goals is to describe and evaluate the differences between the inland (i.e. Starčevo-Körös-Criş) and maritime (ie. Impresso) diffusion axes of the Neolithic in the area, and any subsequent convergence or divergence between cultural trajectories in both areas (Vander Linden et al. 2013).

As a result of this explicit comparative agenda, fieldwork activities focus on the one hand upon northern Bosnia&Herzegovina – where several members of the team have been working for several years now (see Marriner et al. 2011; Vander Linden et al. 2013; Pandžić and Vander Linden in press) – and on the other hand upon southern Montenegro, with excavations during the first three years of the project (2013, 2014 and 2015). In both cases, the chosen areas generally appear as 'blank' areas on archaeological distribution maps, as previously known sites are either very few in number, or completely absent. Indeed, whilst several caves, plus few open air sites, have been excavated in Montenegro and provide exceptional access to the Palaeolithic, Mesolithic and, to some extent, Neolithic periods (e.g. Marković 1985; Kozłowski et al. 1994; Baković et al. 2009; Mihailović 2009), archaeological work has been comparatively limited in the surroundings of Skadar Lake. The EUROFARM fieldwork aims at modifying this documentary imbalance. The selection of the caves was conducted in collaboration between members of the EUROFARM project and Prof. Dušan Mihailović, from the Faculty of Philosophy, University of Belgrade. All fieldwork is conducted under the aegis of the Institute of Archaeology, University College London, the Faculty of Philosophy, University of Belgrade, and the Center for Conservation and Archaeology of Montenegro, represented by Mr. Dejan Gazivoda.

The 2013 investigations were undertaken in two caves, Vezačka pećina and Seocka pećina, both located in the immediate vicinity of the Skadar Lake but in distinct topographical positions. While Vezačka pećina overlooks Skadar Lake, Seocka pećina is located on a small, low peninsula defined by a meander of the Rijeka Crnojevića (Fig. 1). After an initial visit in April 2013, excavations were conducted in early September 2013. Only the results from Seocka pećina are reported here, as the sequence excavated so far in Vezačka pećina only points to historical use of the cave for stabling purposes.

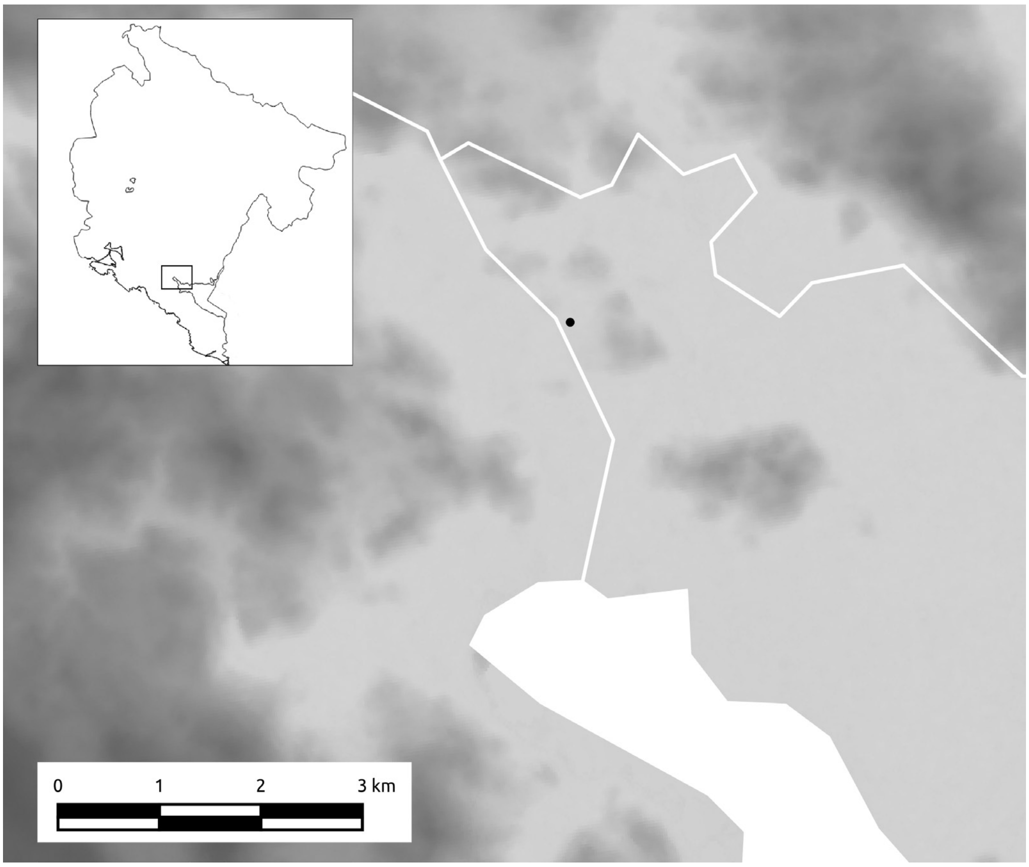

Figure 1. Location map of Seočka pećina.

Seocka pećina (Lat: 42.332; Lon: 19.096)

Seocka pećina is a relatively small cave, approximately 10x30m. Deposits, which were largely destroyed by the construction in the 1920s of two concrete water-wells, take the form of two small terraces at the entrance of the cave, before sloping off towards a third relatively flat area at the base of the cave. Spoil from the 1920s work is apparent on the second terrace, with a fair amount of material culture at the surface, the discovery of which triggered the present excavations. It is also noticeable that the bottom of the cave is subject to seasonal flooding, as was witnessed in April 2013 and 2014.

Work started on Sept. 2nd 2013 by laying down a 2x1m trench on the upper platform, immediately at the entrance of the cave, as it was thought that this area could have been spared during the water-wells' construction. This assumption was proved right by the discovery of an early Holocene layer (see below). Following this discovery, it was decided to extend the trench by opening two further squares (K23-L23), thus giving Trench 1 its eventual L shape. A second trench (Trench 2, also 2x1m) was opened on the second terrace, to the east of the water-wells. As this trench also proved to yield archaeological remains (see below), a further 1x1m test pit was opened in to evaluate the spatial extent of the preserved layers (Fig. 2).

Trench 1

After an initial 10cm of very powdery yellow sediment (Layer 1003, modern diagenetic surface) and a thin layer of pure white silty sand (Layer 1004, erosion of the cave wall), excavations in Trench 1 unveiled a coherent unit, observed across the entire Trench. Layer 1006 presents a marked NW–SE slope, in accordance with the general slope of the cave, and is

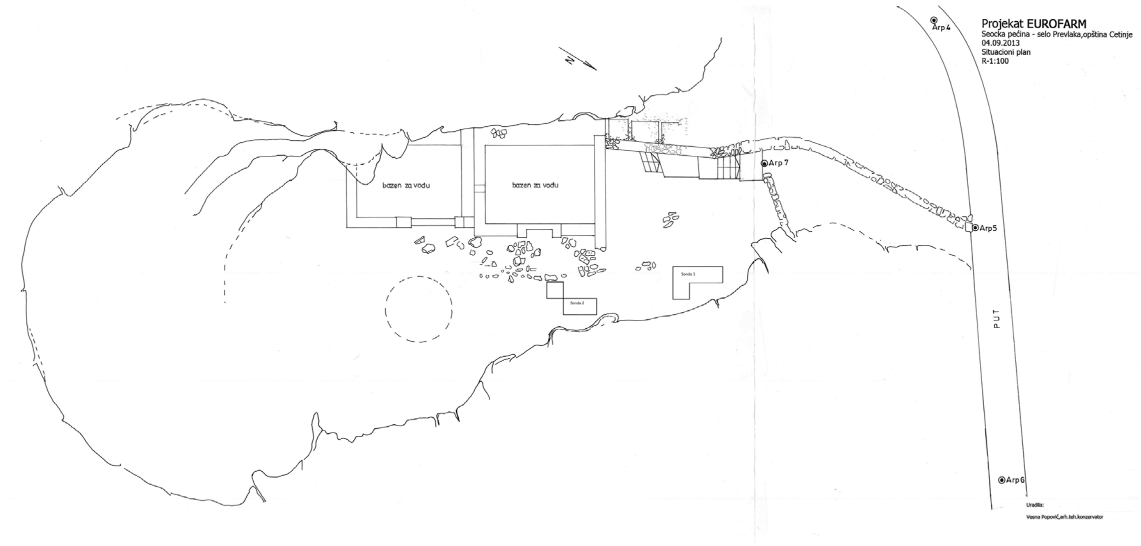

Figure 2. Plan of Seočka pećina, with indications of trenches opened in 2013.

preserved over a maximum depth of nearly 90cm. The sediment is a red/orange loose powdery sandy silt, characterised by a frequent mixture of angular stones of all sizes. Noticeably, the size and frequency of these stones increases towards the base. This layer contained a few lithics, including bladelets, and animal bones. Preliminary visual inspection of the latter suggests that the assemblage exclusively comprises wild animals (e.g. red deer, roe deer, wild caprine, small carnivore and relative dominance of beavers). All these elements suggested, in the field, a possible date to the early Holocene, a chronological attribution confirmed by two radiocarbon dates obtained on bones taken from the middle of Layer 1006. Both dates point to the early centuries of the 8th mill. cal. BC (Fig. 3; Table 1).

Immediately underneath lay a sterile, compact, dark red silty sand and several large angular boulders. Layer 1005 was exposed over the entire surface of the trench, and excavated at a deepest point of 75cm in L21. Unfortunately, given the narrowness of the trench, it proved extremely difficult to remove several of these blocks, largely trapped within the sections. Given its character and stratigraphic position underneath an early Holocene level, it is tempting to associate Layer

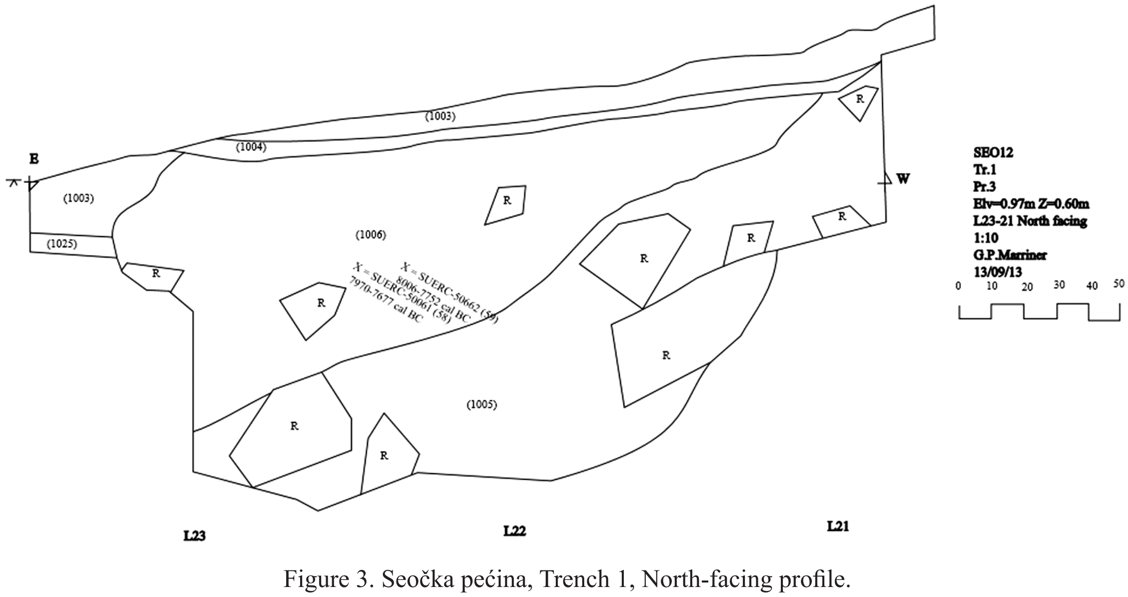

Figure 3. Seočka pećina, Trench 1, North-facing profile.

1005 with the collapse of the roof of the cave, possibly as the result of alternate dry/wet spells in possible combination with cooling events.

The low organic content of all stratigraphic layers is suggestive of a lack of human occupation in this area of the cave as the mildly alkaline slightly oxidised sediment should mean good organic preservation. The dominance of calcium carbonate in Layers 105 and 1006 means that they are more likely formed from the degradation of cave material as opposed to being aeolian or fluvial deposits for example. The relatively high magnetic susceptibility results from Layer 1006, especially in comparison with the readings for Layer 1005, suggest that the sediment was deposited during periods of a warmer and wetter climate (see Ellwood et al. 1997, 2004).

On the basis of these promising results, Trench 1 was extended in both southern and eastern directions, especially to evaluate the spatial extent of the early Holocene deposits, as well as their potential sloping across the axis of the cave. Unfortunately, the deposits were largely disturbed by recent activity in the cave. The discovery of a few potsherds in the top layer (Layer 1022), a brown compact silt, points to the existence of a Bronze Age level in this part of the cave, now mostly eroded away. A pocket of the same early Holocene layer was also observed, and interestingly its base had been entirely stripped of sediments by a water gully (Layer 1024), pointing to the complicated taphomonic factors at play here.

Trench 2

The upper part of the stratigraphy in Trench 2 shows how active recent and sub-recent sedimentation processes are in this part of the cave. The entire surface Trench 2 is covered by a thin layer of grey diagenetic silt, comparable to what had been observed in Trench 1 (layers 1003, 1031). This layer is followed, in the northern half of Trench 2, by a succession of white and grey lenses, which yielded a mixture of potsherds, glass and pieces of plastic. This lamination corresponds to an alternation of deposits from the erosion of the walls of the cave (white lenses) and fluvial deposits, linked to the seasonal flooding of the cave and the vast quantity of water running at the surface after any major rain (as was observed during the field season). Likewise, Layer 1045, a very poorly sorted sand with occasional subrectangular stone (eroded fragments of cave walls), and the presence of a water gully underneath (layers 1047 and 1048) illustrates the importance of water erosion and deposition in this area of the cave. All these layers only produced a limited amount of material culture.

The rest of the stratigraphy in Trench 2 proved to be more compelling, with the discovery of vast quantities of Bronze Age potsherds, some of them of fairly large size; animal bones, including a non-negligeable amount of fish bones; and a few bladelets, the latter comparable to the lithics found in Trench 1. This material culture was trapped in a succession of parallel dark grey and orange layers of sandy silt or silty sand, with a marked NW–SE slope corresponding to the general slope and axis of the cave (Layers 1051–1057). Two bones were selected for radiocarbon, both coming from the bottom of the sequence but from distinct stratigraphic units. Both dates fall into the second half of the 9th mill cal. BC, that is earlier than, but not incompatible with, the dates obtained for Trench 1 (Figure 4). The co-existence, in the same sedimentary matrix, of Bronze Age ceramics and Mesolithic bones and bladelets, indicates that we are here dealing with a series of erosion episodes, mixing together and redepositing in secondary position materials from layers originally located towards the entrance of the cave. This interpretation is reinforced by geomorphological sampling and analyses. There is no consistent geochemical patterning to the successive layers. The redox potential, organic content and pH were consistent through out the profile, this being likely caused by hydrological factors.

At the moment, we do not possess any evidence to provide any precise chronological estimate of this taphonomic process. Whilst the Bronze Age potsherds offer a robust terminus post quem, the lack of remains from the Iron Age or any posterior period suggests that the sedimentary activity of the cave was rather limited until modern times, as indicated by the aforementioned fragments of modern glass and plastic in Layer 1046.

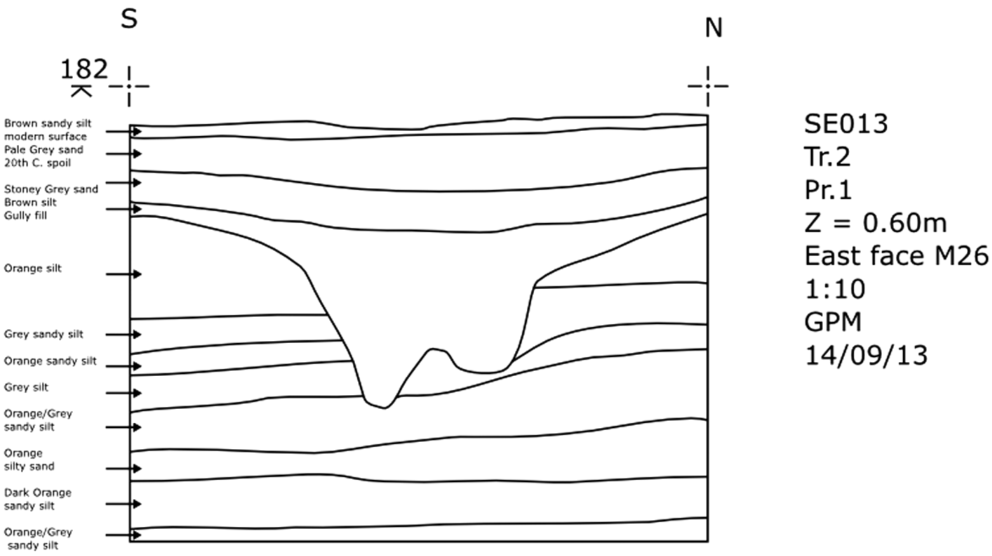

Figure 4. Seočka pećina, Trench 2, East facing profile.

Lab code	Date (BP)	Context	Nature of sample	Calibrated date (cal. BC)
SUERC-50660	8903±34	M29a / o.s. 7	Capreolus capreolus	8228–7963 (95.4%)
SUERC-50656	9311±55	M29a / o.s. 6	Capreolus capreolus	8646–8455 (92.9%)
SUERC-50661	8778±35	L22 / o.s. 5	Capreolus capreolus	7970–7677 (94.6%)
SUERC-50662	8823±34	L22 / o.s. 5	Rupicapra rupicapra?	8006–7752 (73.8%)

Table 1. Radiocarbon dates available Seocka pećina.

Future work

Archaeological excavations will resume in Sept. 2014 in Seocka pećina. Work will include re-opening and widening Trench 1 in the upper part of the cave, in order to maximise finds retrieval from the early Holocene deposits, as well as to get a larger working area which, hopefully, will allow their thickness and nature to be checked. In the lower part, excavations will resume in Trench 2, possibly with the opening of another concomitant trench, in order to get a better understanding of the layers uncovered there, especially regarding the time of their deposition. The use of OSL dating is considered in order to solve the present chronological conundrum. In addition to the current geoarchaeological work, micromorphology will be employed to examine questions regarding taphonomic processes.

Conclusion

The discovery of a late 9th–early 8th mill. cal BC level in Seocka pećina provides the first occurrence of the Mesolithic period in the Skadar lake area, and helps to address the currrent geographical imbalance. Given the limited extent of the excavations, it is impossible to identify the nature of the occupation, but the unusual topographical position of the cave, extremely close to the lake, is worth noting. Likewise, whilst the Bronze Age is is well known in several part of Montenegro (recent examples include for instance Tamnica, Kriti Ponor and Brštanica caves, all near Risan: Szymczak et al. 2010, Kot in press), the overall archaeological record is generally biased towards mounds (e.g. recently Bugaj et al. 2013). As for the Mesolithic period, the original topographical position of Seocka pećina could play a key role in the functional interpretation of the site, and help to widen our vision of Bronze Age settlement strategies. However, particular caution is required given the limited size of the work undertaken so far, and the difficulties in assessing the nature of the deposits.

Although admittedly still in their infancy, excavations in Seocka pećina provide the first step towards a better understanding of cave uses and human activities in the Skadar Lake area. Future excavations to be conducted within the remit of the EUROFARM project will extend this pioneering work and offer a better vision of the prehistoric past in this key region.

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