Chapter 5. Late Pleistocene human settlement patterns in the Central Balkans: Šalitrena Pećina, Serbia

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Abstract

Recent research in the Central Balkans is discovering multiple human occupations previously unknown from the region, revealing its strategical location within Europe for human populations to spread towards Central and Western Europe during the Pleistocene. Šalitrena Pećina (Serbia) contains evidence of late Neanderthal and early modern humans' presence during the mid to late MIS3. A Bayesian model of the radiocarbon dates, combined with the zooarchaeological and stable isotope analyses of the macromammal and technological analysis of the bone tools, provides new insight into subsistence strategies achieved by late Neanderthals and Aurignacian and Gravettian groups at the site. The results reveal diverse residential and short-temporal use of the cave by both human species. Bone tools show intensive use of the carcasses consumed for daily tools. The first evidence of Aurignacian and

Gravettian bone industries in Serbia are presented here. Carnivores played a significant role after humans left the site. Radiocarbon dates indicate a millennium gap between Neanderthal and early AMH groups and a few millennia between the Aurignacian and the Gravettian groups. Bone collagen $\delta^{13}C$ and $\delta^{15}N$ isotope values are indicative of a mixed forest and open landscapes near the cave, reflecting a more forested and humid condition during the Mousterian and colder environments during the Gravettian with open landscapes.

Keywords. Šalitrena Pećina, Serbia, Neanderthals, Homo sapiens, subsistence, stable isotopes, bone tools

Introduction

New evidence of Neanderthal and early modern human occupations in Southeast Europe is forcing the reassessment of theories about the human presence in this particular region. During the Pleistocene, the Central Balkans, in present-day Serbia, was a strategic location within Europe for human populations to spread towards Central and Western Europe throughout the Danubian Corridor (Floss *et al.* 2016; Chu 2018). However, little is known in terms of Palaeolithic about this particular region for several reasons, including the lack of systematic archaeological surveys and/or low human population density at that area, also biased by the abundance of palaeontological sites (mostly by cave bear hibernation sites) (Cvetković & Dimitrijević 2014). However, from the beginning of this century, a boost in chronometric, anthropological and archaeological studies is showing this poorly investigated region is a key area for understanding human dispersals during the Middle and Late Pleistocene (Mihailović 2014a; 2020). Recently, Pleistocene human presence in the region was confirmed at the Balanica Cave Complex (Mala and Velika Balanica) where a mandibular fragment (BH-1) attributed to *Homo heidelbergensis* and dated to a minimum age of 397–525 kyr (Rink *et al.* 2013) was found (Roksandic *et al.* 2011, 2018). Also, a Neanderthal molar (Pes-3) dated to 102.4 ± 3.2 kyr, and a juvenile radius tentatively assessed as Neanderthal (Pes-2), with a wide age margin of 38.9–92 ka, were discovered in Pešturina Cave (Lindal *et al.* 2020; Radović *et al.* 2019), associated with Mousterian artefacts. The new survey and excavations in Serbia, together with multidisciplinary research teams, are providing insights into the life of ancient humans

Research findings from nearby regions such as Bulgaria, Romania and Croatia have highlightedthe importance of this European region for reconstructing human evolutionary processes and, in fact, it was pointing out the role that the central Balkans might have played during Late Pleistocene. On the Croatian coast, several Middle Palaeolithic sites were found (Karavanić *et al.* 2018; Vujević *et al.* 2017), confirming that Neanderthal groups intensively occupied the Adriatic hinterland at the beginnings of the MIS 3 (Dogandžić & Đuričić 2017; Mihailović & Whallon 2017; Whallon 2017). Simultaneously, the presence of AMH in Bacho Kiro (Bulgaria) is dated at 47 kyr cal BP (Fewlass *et al.* 2020; Hublin *et al.* 2020) and in Romania at 42–37 kyr cal BP in Peștera cu Oase showing a Neanderthal ancestral legacy was no more than four-to-six generations back in their family tree (Fu *et al.* 2015). In Serbia, a few sites with Aurignacian deposits have been found, such as Baranica dated to around 41 kyr cal BP (35,780 ± 320 BP - OxA – 13,828), and Tabula Traiana Cave in the Iron Gates Gorge to 41 and 34 kyr cal BP (Borić *et al.* 2012; 2021; Mihailović *et al.* 2011). However, there are no human remains found so far. Nevertheless, all these recent discoveries and dating (Marín-

Arroyo & Mihailović 2017; Alex *et al.* 2019) suggest an extended period of contact between Neanderthals and *H. sapiens* in eastern Europe that was longer than previously thought.

To date, different scenarios have been proposed to explain the rapid dispersal of Anatomically Modern Humans (AMH) and the progressive retreat of Neanderthals populations in southeast Europe. One scenario suggests that Neanderthals would have been pushed towards more marginal western and central areas of the Balkans where they became extinct. A second scenario, on the contrary, suggests that Neanderthals groups progressively retreated to the interior of the peninsula when Upper Palaeolithic groups were already in the eastern Balkans and occupying the most favourable ecological zones (Mihailović 2020). So far, the theory of Neanderthals acculturation in this region is not considered likely due to the absence of transitional industries. Still, there is a limited record of Mousterian sites in Serbia: Smolućka Pećina, Petrovaradin Fortress (Mihailović et al 2011), Pešturina and Hadži Prodanova Pećina (Alex et al 2019 and Milosević 2020) and Tabula Traiana (Borić et al 2021). Recent chronometric data from Pešturina and Hadži Prodanova Pećina, sites with Middle Palaeolithic artefacts provided dates older than 39 kyr cal BP, although with limited human presence and relatively abundant carnivores activities (Alex *et al.* 2019; Milošević 2020).

In this paper, we present the results of the subsistence activities undertaken by late Neanderthal (Mousterian) and AMH during the Aurignacian and Gravettian found in Šalitrena Pećina. This is the only Serbian site where the Middle to Upper Palaeolithic transition has been evidenced (Marín-Arroyo & Mihailović 2017). The chronometric data of the site reveals a late presence of Neanderthals, after which the site was unoccupied until the first Aurignacian groups arrived for a short period of time. A few millennia later, Gravettian groups used the cave as a residential site while exploiting the bovine herds located near the site. The technological and functional analysis of the bone tools has allowed reconstructing the modalities of their production and use. While the stable isotope analysis of herbivore skeletal remains, with evidence of human modification, reveals the environmental conditions at the time both human species occupied the site.

Material and Methods

Šalitrena Pećina

Šalitrena Pećina is a cave with a large rock shelter located near Mionica, in the canyon of the Ribnica river, around 100 km southwest of Belgrade (Figure 5.1a). Ongoing excavations in the cave started in 2004 led by B Mihailović (National Museum of Belgrade) (Mihailović *et al.* 2014; Mihailović 2013, 2008). The excavation focused on two areas: the rock shelter where abundant human presence is documented through time and the inner cave area, where mostly carnivore activities are recorded.

The archaeozoological, technological and stable isotope research presented here is focused on the fauna material documented in the rock shelter during the excavations between 2004 to 2008, except 2005, when excavations were not undertaken. The stratigraphic sequence begins in Level 3

, which, together with Level 4, are attributed to the Gravettian (Mihailović & Mihailović 2007). The few finds found in Level 3 are related to technologically impoverished industries from the Last Glacial Maximum (Mihailović & Mihailović 2007). By contrast, a large number of lithic artefacts were collected from Level 4; furthermore, bone tool fragments were also recorded (Mihailović 2008). Based on preliminary analyses, the lithic industry shows a strong Central European affinity and is very similar to the one which originated from Willendorf II Level 9, dated from 23to 25 kyr BP (Nigst *et al.* 2008). Aurignacian lithic industries were found in Level 5 and Mousterian lithics in Levels 6a and 6c. Typical Balkan Mousterian tools with lateral scrapers, Mousterian points Levallois artefacts and even some leaf-like points were found similar to sites in northern Bosnia and western Serbia, confirming their presence in the peri-Pannonian area (Mihailović *et al.* 2014). Unlike other Aurignacian sites in Serbian Banat, north of Bosnia and Romania, the industry from Level 5 is distinctive with a high presence of carinated endscrapers, burins and retouched and unretouched bladelets (Mihailović *et al.* 2011). Relating to the technological and typological characteristics of the artefacts, they are more closely related to the evolved Aurignacian in central and western Europe (Hahn 1977). In this level, several bone tools, mineral pigments and a bead of *Dentalium* sp. were found (Marín-Arroyo & Mihailović 2017; Mihailović & Mihailović 2007).

Radiocarbon dating

Seventeen radiocarbon dates were undertaken to provide a chronology for the complete sequence at the site covering the Mousterian, Aurignacian and Gravettian levels located outside and inside the cave. With the exception of a shell from Level 5, all the dates were made on bone collagen. Four dates were dated using an ultrafiltration pre-treatment and a shell with phosphoric acid dissolution (Table 5.1). Only one sample failed due to low yield from Level 6d. A Bayesian age model was built for the site using OxCal4.4.2 software (Bronk Ramsey 2009a) with the INTCAL20 calibration curve (Reimer *et al.* 2020) and the marine data from Heaton *et al.* (2020) for the Northern Hemisphere. Beta-237687 was an outlier identified according to the indices method (Bronk Ramsey 2009b) and discarded from the model.

Considering the stratigraphic information of the site, the dates were modelled in a *Sequence* model with stratigraphic levels represented as *Phases*, with start and end *Boundaries*. The difference between the probability density functions of the start and end boundaries was also calculated to estimate the likely duration of the phase. This identified a hiatus between the Mousterian and Aurignacian occupation, as well as between Aurignacian and Gravettian. All radiocarbon determinations were given a 5% prior likelihood of being an outlier within the General t-type Outlier Model (Bronk Ramsey 2009b), so that the model could test their reliability. Convergence was greater than 95% and the model agreement index was 91.9% (Table 5.9). The results were compared with the Greenland ice-core oxygen isotope record (NGRIP) (Andersen *et al.* 2006; Svensson *et al.* 2008) as a global climatic record to correlate each culture with the different climatic phases. The Bayesian model was run five times and the results compared to check the consistency. They disclosed acceptable reproducibility levels when compared, although key boundary parameters were usually within 50–100 years of one another with repetition of the model. This is the usual accuracy expected when using this approach, and consequently, all dates reported here have been rounded to the nearest century.

Archaeozoological analysis

The zooarchaeological analyses focused on the macromammal remains recovered at the cave entrance from those archaeological levels attributed to the Mousterian, Aurignacian and Gravettian periods. Although the Aurignacian and Mousterian faunal results have previously been published (Marín-Arroyo & Mihailović 2017), here we provide a complete zooarchaeological assessment for the entire chronological sequence and therefore review some of the previous analyses. It is noteworthy to say that from 2009 the stratigraphic nomenclature of the levels excavated between 2004 to 2008 was revised. Thus, since then, level 5a is level 5, level 5b is 6a, level 5c is 6c. This change did not affect the cultural attribution, though. In this paper, we have used the updated level nomenclature. The identified bones were quantified by applying the following indices: Number of Identified Specimens (NISP), Minimum Number of Individuals (MNI), Minimum Number of Skeletal Elements (MNE) and Minimum Animal Units (MAU) following Marín-Arroyo (2009a). Biomass calculation was made by multiplying values of useable meat (following the methodology applied in Marín-Arroyo & González Morales, 2009) by the MNI. Due to the high fragmentation, the specimens that could not be identified taxonomically by any distinctive landmark were grouped according to their body size into megafauna (*Rhinoceros*/*Megaloceros*), large (*Bos/Bison*/*Equus* sp.), medium (*Cervus*/*Rangifer/Capra*/*Sus* sp.) and small (*Rupicapra*/*Capreolus* sp.) mammals.

Every element (over 2 cm long) was examined under a LEICA S8 APO stereoscope with 10x eyepieces in search of visible biostratinomic and diagenetic alterations, such as cut marks [grouped as skinning, dismembering and defleshing following Binford (1981) and Pérez-Ripoll 1992], hammerstone percussion marks [including conchoidal notches (Bunn 1981; Capaldo & Blumenschine 1994; Pickering & Egeland 2006), type and angle of fracturing (fresh ‑ green versus old ‑ dry following Vila & Mahieu 1991) and thermoalterations. Carnivore and rodent gnaw marks and digestions traces were also identified, as well as other biological and physicochemical alterations, such as weathering (Behrensmeyer 1978), root etching, insect/fungus activity, carbonate deposits, polishing (Fisher 1995; Lyman 1994;

Shipman 1981), dissolution or mineral coatings (mainly mineral manganese, see Marín-Arroyo *et al.* 2008; 2014). The ungulate mortality pattern (i.e. juvenile, prime or senile individuals) was assessed by both dental eruption and wear stage of pd4, P4 and M3 for ungulates, and upper and lower molars for bear, hyena and wolf following Stiner (1991, 2005). The ratio between juvenile and adult individuals was estimated to measure the pressure on low-return younger prey. The diet breadth and the degree of anthropogenic use of the environment have been evaluated with the Inverse of Simpson's Index for NISP and MNI, whose maximum value equals the number of consumed species only when they are in the same proportion.

The transport of the prey was interpreted by applying the Bayesian method based on a Monte Carlo Markov Chain sampling that uses the available skeletal information to constrain the possible degrees of attrition and carcass processing strategies (Marín-Arroyo & Ocio 2018). This method builds on previous analyses applied to the Mousterian and Aurignacian assemblage (Marín-Arroyo & Mihailović 2017).

Stable Isotope Analyses

To explore the environmental conditions at the time both human species occupied Šalitrena Pećina bone collagen $\delta^{13}C$ and $\delta^{15}N$ analysis of animal bones was undertaken. The species analysed were the most commonly represented, including bovine, horse, red deer and ibex. The aim was to reconstruct past environments and faunal ecologies during the Middle and Upper Palaeolithic and the implications concerning Neanderthal and modern human hunting behaviour. Collagen extraction was undertaken at the Dorothy Garrod laboratory at the McDonald Institute (University of Cambridge), following the methodology outlined in Stevens *et al.* (2013). Extracted collagen was weighed and analysed using a Costech elemental analyser coupled to a Finnigan MAT253 mass spectrometer. All specimens were analysed in duplicate to ensure reproducibility, and an average of these values was used. Carbon and nitrogen results are reported using the delta scale in units of 'per mil' (‰) relative to internationally accepted standards VPDB and AIR, respectively (Hoefs 1997). Based on replicate analyses of international (IAEA: caffeine and glutamic acid-USGS-40) and in-house laboratory standards (nylon, alanine and bovine liver), precision is better than ± 0.2‰ for both $\delta^{13}C$ and $\delta^{15}N$. In total 49 samples were taken, with 21 samples from the Mousterian (Outside cave Levels 6a and 6c and inside cave Level 3), 17 from the Aurignacian (Outside cave Level 5 and inside cave Level 2) and 11 from the Gravettian (Outside cave Level 4) were analysed.

Bone tool technological study

Among the bone assemblage from the Middle and Upper Palaeolithic levels of Šalitrena Pećina 22 artefacts on bone and ivory, which included finished tools, blanks, as well as ornaments, were found. No manufacturing waste was recorded. A total of six osseous tools belong to the Mousterian (Level 6), six to the Aurignacian (Level 5) and ten to the Gravettian (Level 4). A technological and functional analysis to reconstruct the modalities of their production and use was undertaken. The study of archaeological artefacts was based on experimental data (Averbouh & Provenzano 1999; David 2000a; 2000b; 2005a; 2005b; 2009; Campana 1980; Choyke & Bartosiewicz 2001; Patou-Mathis 2002), as well as comparison with experimental reference collection store at the DANTE - Diet and Ancient Technology laboratory of Sapienza University of Rome. Techno-functional traces of Mousterian and Aurignacian tools were analysed using a stereoscope Leica 205 C stereomicroscope with LED lighting (magnifications from 10x to 165x), a Zeiss Axio Zoom stereomicroscope (magnifications from 10x and 178x) and a Scanning Electron Microscope Hitachi T300.

Catchment areas study

To investigate the relationship between the mammals exploited at each cultural period and the environment, the catchment areas associated with the site were calculated, characterising the local relief, following the methodology described by Marín-Arroyo (2009b). A digital model of the terrain around the site was produced, including the continental shelf (CGIAR-CSI SRTM 3-arc seconds (http://srtm.csi.cgiar.org) and EMODnet Bathymetry (https://portal.emodnet-bathymetry.eu/). Travelling times across the territory were estimated with empirical formulae depending on distance, slope angles, movement direction (uphill or downhill) and the existence of insurmountable barriers. Besides, to define the preferred biotopes for plain and mountain species within the boundaries determined by the catchment area, a threshold value of 30% slope was fixed to differentiate areas related to one or the other group of taxa. Beyond that value, grazing suitability is depleted (Holechek *et al.* 1998).

Results

Chronology

The results of the Bayesian model indicate the Mousterian occupation dates to 43,900 and 38,560 cal BP, the Aurignacian between 37,560 and 32,760 cal BP and for the Gravettian between 29,720 and 27,650 cal BP (95.4% likelihood) (Figure 5.2). The end date of the phase of the Mousterian occupation goes beyond the limit for the final Mousterian in Europe, which is dated to around 42 kyr cal BP (Higham *et al.* 2014). In Šalitrena, further dating of late Mousterian levels will be needed to refine the timing of its disappearance but, so far, it provides the latest dates for the Mousterian presence in Serbia. Both hiatuses show an almost a millennium gap between Mousterian and Aurignacian groups and three millennia between the Aurignacian and the Gravettian groups. At Šalitrena, the Mousterian covers GS11 to the end of GI9, finishing before GS9 and the Campanian Ignimbrite eruption (CI) during the Heinrich Event 4. Below Level 6a the chronology goes beyond the limit of the radiocarbon and recent ESR dates on herbivore teeth from Layer 6d and 6e correlated with MIS 5b to early MIS 4 (Dakovic *et al.*2019). The late Aurignacian starts during the end of GS8 and continues into GS6, whilst the Gravettian occurs much later, beginning at the end of the Heinrich Event 3, covering from the GI4 to GI3. Both hiatuses coincided with glacial stages when the cave was unoccupied by humans. The first hiatus took place during the Heinrich 4 along with the GS8 and the second one during the first part of GS5.

Faunal assemblage and origin of the deposit

From the cave entrance, the five studied levels comprised the Mousterian (Levels 6a and 6c), the Aurignacian (Level 5) and the Gravettian (Levels 3 and 4). In total, all the levels yielded 7,411 remains. 11% of the elements were identifiable to taxa and anatomical elements, 27% to mammal body-size and 62% to non-identifiable elements or species. Due to the state of fragmentation of the assemblage, only a minimum number of 548 elements (MNE) were quantified and a total MNI includes 101 different ungulate, carnivore, rodent, leporid, bird and fish taxa. The data of NISP, MNE and MNI values per level and species are presented in Table 5.2.

Among the herbivores, based on NISP, Proboscidea appears during the Gravettian, although the few teeth fragments do not imply their consumption or hunting. Rhinocerotidae is present by *Dicerorhinus hemitoechus* during the Mousterian. Two equid species are present: *Equus ferus*, widely represented throughout the studied levels and *Equus hydruntinus*, exclusively identified in the Gravettian Level 4 with several teeth. Cervidae is represented by *Cervus elaphus* that appears in all the studied levels. *Capreolus capreolus* appear only in one of the Mousterian levels and in the Gravettian, while *Rangifer tarandus* appears exclusively in Level 4. Among Bovidae, in Level 4 it was possible to distinguished between *Bison priscus* and *Bos primigenius*, but not in the other levels, where a general category of *Bos/Bison* sp. was used. *Capra ibex* appear in all the levels, but *Rupicapra rupicapra* are only present in small numbers in Mousterian levels and Gravettian Level 4. *Sus scrofa* is only identified in Level 3. Among the carnivores, *Ursus spelaeus* is highly represented during the three cultural periods. *Panthera pardus* and *Panthera leo* both appear, with an element each, in Level 5 and panther also in Level 4, as well as *Lynx sp.* in Level 6c. *Felis silvestris* is only found along with the three Mousterian levels. Along the sequence, *Crocuta spelaea* is represented although minimally, whereas *Canis lupus* and *Vulpes vulpes* appear evenly distributed. Among the mustelids, *Martes martes* and *Mustel*a sp. are represented during the Mousterian. Leporids appear in the Aurignacian and Gravettian. Several bird elements are represented along the sequence.

The taphonomic analyses discerned the origin of the deposit. Previous studies confirmed that large mammals from both the Aurignacian and Mousterian levels were brought to the cave by humans. The large mammals had a more significant amount of butchering marks, while medium mammals showed more gnawing evidence, although still a lower percentage than cut marks. In the Mousterian Levels 6a and 6c, medium mammals show evidence of being accumulated first by humans and later scavenged by carnivores. Overall, the Mousterian and

Aurignacian deposits were clearly linked to human activity. During the Gravettian, Level 4 shows abundant evidence of human activity. In fact, it is the richest archaeological level of the site and the percentage of cut marks and patterns of fresh bone fracture indicates intense human exploitation, on mostly large mammals, with limited evidence of carnivore presence (Table 5.3). However, Gravettian Level 3 show very limited evidence of human modifications on the faunal assemblage. When excluding the cave bear, the ratio of carnivore/ungulate in NISP is higher in Level 6a, followed by Levels 3, 5 and 6c, being ratio zero in Level 4.

Palaeoeconomy

Once the taphonomy of the site is disentangled, the taxa represented can be interpreted economically. Large mammals played an essential role in the diet of the human groups at the site. In terms of MNI, during the Mousterian and Gravettian, bovines are the most exploited species with 26% and 33%, respectively, while during the Aurignacian, it is red deer the most common taxa with 43% (Table 5.2). Apart from bovid hunting, Neanderthals exploited also ibex (22%), horse (17%) and red deer (22%). The mammals consumed by Aurignacian groups are also represented by ibex (29%), bovid and horse (both 14%). The Gravettian groups also consumed red deer (19%), horse (13%) and ibex (12%). Bovids, horse, red deer and ibex encompassed 86% of the Mousterian assemblage, 100% of the Aurignacian and 78% of the Gravettian. Other mammals, such as megafauna represented by a few fragments of Proboscidea teeth in the Gravettian and some bones and teeth of rhinoceros during the Mousterian. Reindeer is only found in the Gravettian, as well as wild ass. This is the first time both taxa have been recorded in the Serbian Palaeolithic. Small mammals, such as roe deer and chamois, appear in low percentages and any of them during the Aurignacian. During the Gravettian, roe deer increased to 9% from 4.5% during the Mousterian. Chamois decreased to

1.5% from 4.5% during the Mousterian. Wild boar appears exclusively during the Gravettian, comprising 7% of this assemblage.

In terms of biomass, bovines are the most important species providing the maximum input of proteins, followed by horse and red deer, as shown in Figure 5.3. Rhinoceros, which appears only during the Mousterian, has been excluded from this biomass calculation despite having cut marks and breakage fracture on half of the few bones identified, as it was represented only by two individuals. During the Aurignacian, although red deer is the most abundant taxa in terms of MNI, when it comes to biomass, it is exceeded by bovines. The contribution of ibex and small mammal biomass is limited in all the levels where it appears. These taxa profiles of large mammals (bovid and equids) together with red deer would reflect exploitation of the closer fluvial plain biotopes and forested areas, located not far than 1.5 hours from the site as reflected in Figure 5.3.

Comparatively, the Inverse of the Simpson index is slightly higher when calculated with MNI than NISP as seen in Table 5.4. The results indicate a similar diet breadth during the Aurignacian and Gravettian Level 4, reflecting the exploitation of bovids, followed by equids and red deer. On the contrary, during the Mousterian, a sawtooth pattern is seen through the levels. The values in Gravettian Level 3 and Mousterian Level 6a are similar, probably reflecting both short-term human occupations and most of the prey brought by carnivores. In addition, these results correlate with the representation of ungulates body size.

Ungulate mortality profiles and seasonality

During all three cultural periods, there is a predominance of prime-age individuals, followed by juveniles. However, it is remarkable during the Gravettian the high percentage of foetal and neonatal bovid individuals, which indicates the massive hunting of pregnant female bovids or just after birth animals. Among the 17 bovid individuals identified, six of them belong either to foetal and/or neonatal. This indicates late spring-mass hunting by Gravettian people, as seen at the Gravettian site of Buda in Romania (Dumitraşcu & Vasile 2018). Within the Aurignacian Level 5, some evidence suggested a possible autumn occupation, while during the Mousterian is uncertain. By looking at the ratio between juvenile and adult individuals, the results show the following values: Mousterian 0.41, Aurignacian 0.25 and Gravettian 0.61 or 0.94 (by considering the foetal/neonatal specimens).

Skeletal profile representation

For the analysis of the skeletal profiles, a Bayesian method following Marín-Arroyo and Ocio (2018) was applied to disentangle the prey's transport and the attrition that occurred at each level. This new method is more robust than the previous one, used to the Mousterian and Aurignacian levels and published in Marín-Arroyo and Mihailovic (2017). From the Mousterian and Aurignacian levels, the mammals were grouped by body size due to the limited sample size of individual taxa. In the Mousterian, the results suggested that an appendicular transport and, probably, head and truck was undertaken for large and medium mammals. However, the possibility of an initial butchering process of some body parts at the kill site cannot be discarded. Yet, the attrition is higher for medium mammals than for large ones. During the Aurignacian, large mammals were processed more extensively at the kill-site than during Mousterian, by contrast, medium mammals were less processed. For the Gravettian Level 4, it was possible to consider the bovids (excluding the foetal remains), red deer, horse and ibex species separately. The results indicate that among the different species, the horse was highly processed at the kill site, with an exclusive transport of limbs to the site.

The alpha values are the highest of the cultural sequence. Red deer was also intensively processed, although not as intensively as the horse. Ibex was transported, almost complete, and bovids were minimally processed at the kill-site, suggesting a mainly entire carcass transport. Regarding the attrition, it was higher in ibex and horse, followed by red deer and the lowest one was found in bovids, the most bone dense individuals. Nevertheless, these results must be considered with caution due to the small sample size for some of them, as shown in Table 5.5. Outcomes related to small mammals were not considered due to the small sample available.

There were abundant signs of marrow extraction at all levels. The degree of fragmentation (measured as the quotient between NISP and MNE) correlates positively and significantly with Marrow Index (Binford 1981) for medium mammals in Mousterian Levels 6a and 6c and Gravettian Level 4. For large mammals, there was also a positive and significant correlation during the three cultural periods, as previously demonstrated (Marín-Arroyo & Mihailović 2017). Also, there is evidence of grease exploitation. In the taxa found in the Gravettian Level 4 (red deer, ibex, bovid and equids), the Spearman's correlation coefficient between Grease Index and %MAU shows a positive and significant correlation with bovid (0.76), horse (0.67), red deer (0.69) and ibex (0.67). In the four taxa, the *p* was statistical significance (0.00).

Mobility patterns

To discern the mobility patterns, that could have achieved from the cave site, it is important to understand the human-environmental exploitation. Disentangling the human mobility patterns allows the assessment of how the different human groups exploited the available resources according to the climatic conditions at each stage and thus, ensuring their survival possibilities. In this sense, the topographic characterisation of nearby catchment areas from Šalitrena Pećina and its comparison with the type of animals consumed in each cultural phase was estimated following the methodology Marín-Arroyo (2010). Table 5.6 shows the percentage of areas below and above 30% slope calculated for 1.2h and 2.15h from the cave. Figure 5.4 shows the catchment areas corresponding to different travel times around Šalitrena Pećina.

As can be seen in Figure 5.4, the presence of fluvial plains in the vicinity of the cave surrounded by small hills, suitable for forest development, would have been a favourable environment for large mammals, such as bovids and horses, widely represented through the sequence (Figure 5.5). The cave location might explain the low carcass processing at the kill site which is suggested by the mainly complete transport of those prey during the Gravettian. Within a 1.2h from the site, the catchment area below 30% slope would have been disposed of chamois and ibex, although chamois might have lived above that slope, depending on the season. In summary, within the distance of 1.2h from the cave, both human species would have had available all types of ungulate taxa adapted to open landscapes, forested and mountain ones. By looking at the MNI of ungulate taxa, grouped by environmental habitat, grassland animals (41%) are predominant during the Mousterian, followed by rocky (32%) and forested (27%) ones. During the Aurignacian, by contrast, woodland species predominate (43%), and open landscapes and rocky areas species are represented, both, by 29%. During the Gravettian, forested animals show the lowest proportion of the sequence (16%), probably linked to the cold environmental conditions at that time, as reindeer and wild ass appear exclusively in this period. Grassland animals show the highest percentage (51%) at the three periods, as well as rocky species (34%) (Figure 5.5). These results suggest that hunting decisions were adapted in response to the MIS3 climatic conditions. The sources of the raw materials near the site will also contribute to the knowledge of human mobility patterns (results are expected soon).

Technological features of the lithic assemblage

The Middle Palaeolithic industry of Šalitrena Pećina provided 589 artefacts (Mihailović, 2017). The industry is dominated by the products of flaking from discoid cores. Levallois artefacts are also present, while the Quina component is poorly represented. The tool assemblage is dominated by sidescrapers, denticulated and notched pieces and retouched flakes, while other types are less represented. The upper Level (6a) yielded Mousterian points, massive borers and typologically differentiated denticulated tools, while in one of the deepest levels (6d), a bifacial sidescraper was found. On the terrace facing the Šalitrena Pećina, a bifacial Szeletian point was discovered in a stratigraphic context (Mihailović *et al.* 2014). The Level 5 Aurignacian industry includes about 2,000 artefacts. Most were produced on the spot, using low-quality local flint (Mihailović 2013). Various core types were found, including bladelet cores resembling carinated and nosed endscrapers. Among the tools, scrapers, burins, Aurignacian and pointed blades were recorded. Spatial analysis showed the artefacts to be concentrated around combustion zones (Plavšić *et al.* 2020). A slightly larger number of bladelets were found in the fireplaces, while the zones that could be associated with workshops and other types of activities were confirmed outside of the fireplaces. Several tens of thousands of artefacts were excavated from the Gravettian level. Different types of quality flint were used in tool production, as well as magnesite from nearby deposits. The assemblage structure records artefacts from all phases of production. Massive single-platform, double-platform prismatic and burin-type cores, as well as cores used for the production of micro-bladelets were found. The variability of tools is very pronounced, especially when it comes to endscrapers, burins and backed tools. Backed bladelets and points with thinned base, backed, double truncated bladelets resembling rectangles and shouldered points are represented among the backed tools. A significantly narrower artefact repertoire comes from Level 3; it includes simple, backed points and bladelets, endscrapers on flakes, and other not so characteristic tools.

Technological features of the bone tools

During the Mousterian, six bone diaphysis of large ungulates show in their dorsal surface aggregations of stone knapping marks, suggesting their use as retouchers. Given the homogeneous nature of the lithic traces on the surface in the used areas, the retouchers were probably used for a short episode of retouching activity. At the Aurignacian Level 5, the artefacts recovered were three perforating tools (two symmetrical awls and one distal fragment of a point) and one proximal bevelled fragment. All the specimens are fragmentary with deep longitudinal grooving marks and characteristics "chattermarks", which suggest that the longitudinal grooving technique was used to extract regular blanks from bone diaphysis and later regularised through scraping. Functional traces are developed on all the tools. Their nature suggests that both awls were used in longitudinal motions on the vegetal material, while on the point fragment, an invasive hinge fracture is visible. The bevelled piece shows developed rounding and faceting, changes in colours and compression marks supporting its insertion in a haft. Besides, at the same level, two entire beads made out using segments of *Dentalium* sp. were found. Developed rounding was identified on both extremities of one specimen, which might indicate the utilisation of this ornament.

The artefacts recovered from the Gravettian Level 4 include an osseous blank, an entire point, a proximal end of a point, a blank on a rib, three awls, an expedient tool on a flake, an ivory plaquette and one fragment of ivory, as shown in Figure 5.6 and 5.7. Except for the osseous point and the long blank, all the artefacts are fragmentary. No manufacturing traces related to the blank extraction were identified on the points, while longitudinal lithic striations are well-represented on osseous surfaces. Both points, the entire and the fragmentary piece, present developed traces of use. In particular, impact fractures have been documented on the whole tip of the points, while compression marks and rounding affect basal parts. On the meso-proximal part of the entire point, the modification of the outline, rounded surfaces, the presence of fungal activity and the change of the colour in the proximity of the base could sustain the presence of an organic hafting. The two awls were produced on expedient diaphyseal flakes, and their tips were created through flint scraping. No diagnostic traces have been recorded on the tools. On the unfinished rib blank, small impact side cones suggest that indirect percussion was used for extracting the blank from the rib. The same technique was utilised to split the rib longitudinally. Within the Gravettian production, of particular interest are two ivory fragments. The first is a small fragment in a bad preservation state. The other is a flat black ivory plaquette, also fragmentary. One extremity is missing, and the other is well-rounded. Given the fragmentary state of the artefact, it is difficult to understand its function and its implications in terms of subsistence. However, the homogeneous black colour and shiny appearance suggest the item underwent a controlled thermal treatment.

Stable isotopes results

Except for the reindeer found in Level 4, the recovered macromammals reflect a landscape typically consisting of forested and grassland environments, which is consistent with the temperatures and the palaeoenvironmental reconstructions of the glacial MIS3 for Eastern

Europe (for example, climatic simulations of GS12 with RCA-3 model coupled with LPJ-GUESS dynamic vegetation model, shows that the region was then dominated by semi-open areas, with a tree cover c. 50–70% Kjellström *et al.* 2010). The stable isotope results are presented here for each species and full results are provided in Table 5.8.

Bos/Bison sp.

The *Bos/Bison* sp. $\delta^{13}C$ and $\delta^{15}N$ isotope results have a relatively wide range indicating isotopic diversity in the plants habitually consumed by this species. Between the Mousterian and the Gravettian, there was no notable change in the $\delta^{13}C$ values of *Bos/Bison* sp. and no statistically significant differences were seen between Levels 4 and 6a for either $\delta^{13}C$ or $\delta^{15}N$. Within Mousterian Level 3 (located inside the cave), there is a notably broader inter-individual range of 5‰ in the $\delta^{15}N$ values, larger than seen in any other level. The three bovids from Aurignacian Level 2, also inside the cave, have higher $\delta^{15}N$ values (min 7.2‰, max 9.3‰) than those seen in Aurignacian Level 5 outside (min 5.0‰, max 6.1‰) (Figures 5.8 and 5.9, Table 5.7).

Bone collagen $\delta^{13}C$ and $\delta^{15}N$ isotope values reflect long-term, average diet consumed, meaning that $\delta^{15}N$ difference seen in those inside levels reflects differences in the habitual diet of those individuals. There is a range of factors that can affect the $\delta^{15}N$ values in plants and their consumers. Baseline shifts in $\delta^{15}N$ values can occur due to larger-scale climatic processes, such as a change in temperature (Martinelli *et al.* 1999; Amundson *et al.* 2003; Pardo *et al.* 2006), rainfall and moisture (Austin & Vitousek 1998; Handley *et al.* 1999; Amundson *et al.* 2003). If these differences in *Bos/Bison* sp. $\delta^{15}N$ values at Šalitrena were due to large scale climatic effects, we might expect a shift in $\delta^{15}N$ reflected in other contemporary species, and an associated change in $\delta^{13}C$ values, which might impact the $\delta^{13}C$ values of plants (Diefendorf *et al.* 2010; Farquhar *et al.* 1989; Kohn, 2010; Stewart *et al.* 1995). Only *Bos/Bison* sp. species show this trend, suggesting that factors specific to these herbivores' niche may be responsible.

Environmental factors can cause geospatial variations in $\delta^{15}N$ values. Key factors that can affect plant nitrogen isotopic variation spatially include the types of nitrogen-fixing mycorrhiza present (Craine *et al.* 2009; Hobbie and Högberg 2012), soil acidity (Mariotti *et al.* 1980), and openness of the nitrogen cycle, amongst others (see Szpak 2014). The presence of isotopically different $\delta^{15}N$ zones within site catchment areas has been observed in Middle and Upper Palaeolithic contexts thought to be due to animal populations being separated by geographical boundaries such as valley systems or mountain ranges (Jones *et al.* 2018, 2019). At Šalitrena, *Bos/Bison* sp. could potentially have been hunted by humans from isotopically diverse locations within the landscape. Alternatively, they may have been accumulated by two different agents that targeted prey from other areas and in the landscape and probably periods. The inner parts of the cave, where both Levels 2 and 3 were situated, contained greater carnivore activity and presence, mostly hyaenas and cave bear. Even though the two *Bos/Bison* sp. with higher $\delta^{15}N$ values from Level 3 were metatarsal fragments, without evidence of gnawing marks, the abundance of carnivore activity is notable within the inner part of the cave (Marín-Arroyo & Mihailović, 2017), and could be potential agents responsible for the accumulation of some of these remains.

Alternatively, it cannot be discarded that the inter-individual $\delta^{15}N$ value differences represent temporally different environmental conditions, such as flooding instances. Open fluvial plains surrounding the site were the most likely habitat for them. Water table heights within fluvial plains can affect nitrogen availability in soil, with regions of lower water tables typically having higher $\delta^{15}N$ values than areas with higher water tables (Hefting *et al.* 2004).

Cervus elaphus

Within inside Mousterian Level 3 and outside Level 6c there are two deer with $\delta^{13}C$ values of -22.5‰, and -22.9‰ respectively (Figure 5.8 and 5.9), potentially indicative of them regularly feeding in forested environments, under the influence of the canopy effect (van der Merwe & Medina, 1989, 1991). This suggests that woodland habitats were present within the catchment areas from the site at that time both assemblages were accumulated. Roe deer, a forest-dwelling species (Tufto, *et al.* 1996), found in Mousterian Level 6a (Marín-Arroyo & Mihailović 2017) also supports this possibility. The absence of a canopy affects signature within other red deer from the same levels, demonstrates that some red deer lived in open spaces, and suggests a mosaic of environments in the region. However, the temporal formation of the archaeological level must also be considered. In the Aurignacian and the Gravettian, all individuals have $\delta^{13}C$ values consistent with feeding in predominantly open landscapes. It is possible that there was either a decline in forest areas during the Aurignacian or that AMH were not exploiting the forested regions that the Neanderthal predecessors were occasionally doing. This might be related to the longer distances travelled to select prey by AMH at the site. Further archaeobotanical work will be needed to confirm this interpretation.

Equus sp.

In all levels, there is an overlap in the $\delta^{13}C$ and $\delta^{15}N$ values of the horse and the large bovids (Figures 5.8 and 5.9). Horses are thought to preferentially select low quality vegetation that is poor in protein (Gwynne and Bell 1968; Janis 1976), and might be expected to have lower $\delta^{15}N$ values than other herbivores, as seen in some Palaeolithic contexts (Britton *et al.* 2012; Fizet *et al.* 1995). This is not consistently observed throughout Palaeolithic Europe, and similarities in the niches of horse and large bovids are seen in other sites (Bocherens *et al.* 2014; Richards *et al.* 2008). Recent big data studies have shown that the niches of horses and bison vary geographically and temporally and that the two species commonly overlap (Schwartz-Narbonne *et al.* 2019). The similarity of the horse's niches and large bovid at Šalitrena indicates that there was sufficient food in this habitat for both species to co-exist successfully.

Capra ibex

The ibex have $\delta^{13}C$ values within the higher range for ungulates analysed at the site, as shown in Figures 5.8 and 5.9. Higher altitudes can produce elevated $\delta^{13}C$ values in plants and their consumers (Kohn 2010). Modern-day ibex populations show a habitat preference for altitudinous rockier escarpments (Grignolio *et al.* 2004; Parrini *et al.* 2009). The Šalitrena ibex appear to have been living in higher altitudinous environments relative to the other herbivores studied. The closest suitable habitats are within the limits of the 1.2h catchment area calculated from the site.

Discussion

New evidence of the subsistence strategies of human groups that occupied Šalitrena Pećina, has been revealed through the taphonomic and archaeozoological study of the complete faunal assemblage located outside the cave that covers from the Mousterian to the Gravettian. These results, in combination, with a Bayesian model of the available radiocarbon dates at the site, the lithic and bone technology study and the palaeoenvironmental data, derived via stable isotopes, provide new insights into the activities carried out at the site, the use of the cave by both human species and the type of landscape present when late Neanderthal and AMH occupied Šalitrena Pećina. The assemblage from Šalitrena also provides the first evidence for the use of osseous technology from the Mousterian to the Gravettian in the central Balkans.

The chronometric data of the site covers the Middle to Upper Palaeolithic sequence and show the latest presence of Neanderthals in this particular region, between 43.9 and 38.5 kyr cal BP. They were present at the site during GS11 to the end of GI9, leaving the site unoccupied at GS9, just before the Campanian Ignimbrite and the HE4. It has been hypothesised that Neanderthals groups may have survived longer in these inaccessible areas, where they were likely relegated after the dispersal of AMH along the Sava and Danube rivers around 42 kyr cal BP (Conard & Bolus 2003; Conard *et al.* 2006; Jöris *et al.* 2010; Mihailović 1998; 2004; 2020). Our new dates at Šalitrena Pećina confirm this hypothesis, together with dates from Mousterian sites such as Mališina Stijena (Radovanović 1986), Smolućka Pećina (Kaluđerović 1985) and Pešturina (Blackwell *et al.* 2014) may confirm this hypothesis.

Neanderthals were probably at Šalitrena repeatedly, for short-time episodes, as indicated by the faunal and lithic assemblage during late MIS3 and even during MIS4. After humans left the site, carnivores played a role as secondary scavengers. Differences in the space use of the cave between the outside and the inside were observed. Most human activities were concentrated outside the cave, while mainly carnivores used the inside as a regular habitat. Cave bears regularly hibernated in the cave, evidenced by several old and infantile individuals found, along with some rounded bed-shapes identified during excavation and claw marks on the walls (A. Ruiz-Redondo, pers. comm.). Modifications recorded on the bone assemblages from Levels 3 and 2 indicate that hyaenas were also present in the inner part of the cave. The large inter-individual in $\delta^{15}N$ ranges between *Bos/Bison* sp. in Mousterian Level 3, and the higher $\delta^{15}N$ values within Aurignacian Level 2 may reflect factors specific to the niche of this species, indicating isotopically distinct zones being exploited at different times and temporal changes in their habitats. However, the high carnivore activity recorded in those levels might be reflecting diverse landscapes at the time carnivores were roaming at the site. The zooarchaeological study from the inner cave will provide more data.

Neanderthals mainly exploited prime-age bovids, followed by ibex, horse and red deer, although red deer was not identified in the lower Mousterian sequence. This implies broad and efficient exploitation of the areas surrounding the site. In fact, the stable isotope results potentially show some forested areas when Neanderthals inhabited the site. However, the isotope values during the occupation of AMH indicate an open environment. This is broadly consistent with environmental reconstructions from the wider region (Panagiotopoulos *et al.* 2014). Both horse and large bovids overlap in $\delta^{13}C$ and $\delta^{15}N$ values, suggesting that they occupied similar niches, and the plains surrounding the site were able to support both species throughout the Middle and Upper Palaeolithic near Šalitrena.

Concerning bone technology, retouchers are predominant within the Mousterian level. They are well-known within Middle Palaeolithic osseous technology, particularly for their low degree of transformation in Western Europe (Costamagno *et al.* 2018 and references therein) and northern Asia (Baumann *et al.*2020 and references therein). At Šalitrena Pećina, they were produced on flakes extracted from long-dense bones of large mammals through direct percussion.

Before Šalitrena Pećina, the presence of early Upper Palaeolithic humans was restricted to the northern Serbian border, along the Sava and Danube rivers, a fluvial corridor commonly proposed to explain how early modern humans arrived in Swabia around 42 kyr cal BP (Mihailović and Mihailović, 2014). However, the Mousterian sites of Mališina Stijena (Radovanović 1986) and Smolućka Pećina (Kaluđerović 1985) dated to before the 40 kyr cal BP (Hedges *et al.* 1990), and along with the new dates from Šalitrena Pećina, it is pointing out that late surviving Neanderthal populations existed in inaccessible areas of the central Balkans (Mihailović, 1998; Mihailović *et al.* 2011).

The presence of modern humans in the Bulgarian site of Bacho Kiro (between 47 and 43 kyr cal BP; Hublin *et al.* 2020), the Italian Uluzzian (between 45 and 40 kyr cal BP, see Douka *et al.* 2014), the German site of Geißenklösterle (between 43 and 41 kyr cal BP, see Higham *et al.* 2012), the Aurignacian of northern Iberia (c. 42 kyr cal BP; Marín-Arroyo *et al.* 2018), and the KC4 maxilla of Kent's Cavern in the United Kingdom (between 44 and 41.5 kyr cal BP, see Higham *et al.* 2017), together suggest that the spread of modern humans throughout Europe was rapid. Today their period of coexistence with the preceding Neanderthal is estimated to be around 7,000 years (Fewlass et al., 2020). From Ust'-Ishim in Siberia (Fu *et al.* 2014), the first *Homo sapiens* expanded rapidly into Western Siberia and eastern Europe at Bacho Kiro approximately 47-45 kyr cal BP. These early dispersals suggest rapid movements from southwestern Asia into Eurasia by groups that seem unrelated to present-day European populations (Fu *et al.* 2014; Hublin *et al.* 2020). Therefore, an earlier contact of these AMH with Neanderthals would have taken place earlier in Eastern Europe than in Western Europe (Hublin *et al.* 2015; Marín-Arroyo *et al.* 2018). In this scenario, the hypothesis of the Danube valley proposed as a major colonisation route into central and western Europe from the Near East would be evidenced by the sites of Baranica and Tabula Traiana, which provided the first radiocarbon dates for early Aurignacian in Serbia, dated to between 41.5 to 34.5 kyr cal BP (Borić *et al.* 2012; 2021; Mihailović *et al.* 2011). Thus, the late Mousterian dates in Šalitrena Pećina would confirm a likely withdrawal of Neanderthal groups from the fluvial Danube plains into the more mountainous territories of the central and western Balkans (Mihailović 2020). Our data confirm all these hypotheses in a yet poorly investigated area during the Late Pleistocene.

The archaeological evidence and radiocarbon dates show one of the richest Aurignacian sites in the central Balkans. The results indicate brief human occupations during the Aurignacian. The spatial distribution of the combustion features detected, one in the front cave in Level 5 and another likely in Level 2, indicates that in the front of the cave, the hearth was relatively small and probably not used very intensively or extended period. It was proposed that no more than five people could have been performing activities around the combustion area (Plavšić *et al.* 2020). The limited lithic and faunal assemblage also confirms this. Concerning the subsistence strategies, a shift in the diet is observed compared to the previous period. Red deer played an important role in AMH diet, although bovids biomass is also relevant.

Regarding the transport of those carcasses, AMH processed large mammals at the kill-site more intensively, while by contrast, they less processed medium mammals than Neanderthals. During the Aurignacian and Gravettian, similar diet breadth and use of the cave is observed, unlike during the Mousterian. The woodland species predominate, followed by open landscapes species and those typical of rocky areas. However, during the Aurignacian and also the Gravettian, all individuals have $\delta^{13}C$ values consistent with feeding in predominantly open landscapes. It is possible that there was either a decline in forest areas at that time or that AMH were travelling long distances to select those woodland prey. Despite the short temporary occupations, new manufacturing techniques are introduced to produce osseous tools. Longitudinal grooving is one of the methods widely documented during this period across Europe and, generally applied to extract regular blanks from antler and bone shafts, later transformed into points (Tartar 2009, 2012; Tejero 2016). At Šalitrena, regular striations identified on all the tools' surfaces suggest they were carefully shaped through scraping. However, the absence of manufacturing waste or unfinished artefacts makes it challenging to understand whether osseous tool production was carried out at the site.

Very little is known about Aurignacian osseous technology in the Balkan peninsula (Tartar 2015). Yet, several osseous points found in the Aurignacian levels of Potočka zijalka in Slovenia (Odar 2011) are particularly relevant for discussing osseous technology at Šalitrena. At Potočka zijalka, several lanceolate and spindle-shaped points and one split-based type have been directly AMS dated to the Late Aurignacian (Moreau *et al.* 2015). Unfortunately, no assumptions can be made about the original shape of the fragmentary point from Šalitrena. Its chronological attribution, through direct AMS dating (Marín-Arroyo & Mihailovic 2017), is Late Aurignacian and its morpho-technological features (e.g., thickness, symmetry, specific use-damage of the preserved part as well as the technique of blank extraction and surface shaping) allows a comparison with the massive projectile osseous points from Potočka zijalka cave. Osseous points, including some split-based specimens, have also been identified in the level G_1 of Vindija Cave, in Croatia (Deviese *et al.* 2017). Bone technology from this cave is, however, problematic as it is associated with Neanderthal human remains and perturbation in the archaeological sequence (Deviese *et al.* 2017). While a recent attempt to (re)date one split-based point from Vindija has failed due to insufficient collagen (Deviese *et al.* 2017), the age of split-based points from the site likely falls somewhere between 35–37 kyr cal BP., when such tools are also documented in other regions of European. Šalitrena Aurignacian levels also yielded a fragmentary beveled specimen, extracted with longitudinal grooving and carefully shaped through scraping. Beveled implements are not uncommon within the Aurignacian osseous tool repertoire of Europe and western Asia (Tartar 2015). Although less abundant than the split-base, spindle-shaped, and lozenge-shaped points, beveled points are also known during the Late Aurignacian (Clark & Riel-Salvatore 2005; Tartar 2015). At

Šalitrena, functional modifications on the beveled artefact suggest its prolonged insertion in a handle. Hence, the possibility that this fragmentary specimen might have been part of a beveled point cannot be excluded *a priori*. Last, the recovery of two dentalium shell ornaments testimonies of such shell's role for the production of personal adornments during the Aurignacian in this region, similarly to many other areas in Europe (Clark & Riel-Salvatore 2005; White 2007) and suggest the contact with other groups and might be the long-distance mobility as the Adriatic Sea is almost 400km far away.

When it comes to Gravettian, the results of the research of Šalitrena Pećina and other Gravettian sites in Serbia seem to support the hypothesis of the refugial role of the Balkans during this period. The dates obtained for Levels 3 and 4 (29,720-27,650 cal BP) coincided mostly with GI4 and lasted into GS3 (Rasmussen *et al.* 2014). GS3 marks the beginning of the Last Glacial Maximum in this particular region, which lasted until 22.7kyr cal BP (NGRIP curve) (Scrapozza *et al.* 2019). This indicates that Šalitrena Pećina was probably intensively inhabited during the interstadials (GI4 and GI3) just before the beginning of GS3, at a time when the ecological conditions in the Balkans were still relatively favourable. Level 4 shows a residential use of the cave by AMH, where many bovids were exploited, some of them with foetal or neonatal specimens, suggests a communal mass kill, where a selection of individuals by sex and age was planned by the Gravettian groups. This archaeological population reflects predatory exploitation during late spring-early summer in the vicinity of the cave at the time of calving. The exploitation of large bovids in a similar way is documented in contemporaneous sites such as Buda in Romania and Aitzbtarte III in Spain (Altuna *et al.* 2011, 2017).

Several Gravettian sites have been explored and dated recently in the central Balkans, chronologically corresponding to the interval between 31- 29 kyr cal BP. These include

Pešturina (Level 2), Hadži Prodanova (Level 2) and Meča Dupka (Level 3) caves; the Gravettian age (29 kyr cal BP) was also confirmed for the finds from Level X of Crvena Stijena (Alex *et al.* 2019; Mercier *et al.* 2017; Plavšić & Popović 2020). Research at these sites has provided a somewhat more precise picture of the presence of Gravettian communities in the Balkans, previously confirmed only at the sites of Temnata dupka (Drobniewicz *et al.* 1992) and Kozarnika in Bulgaria (Tsanova 2003), but also at Asprochaliko in Greece (Adam 1988).

Compared with the lithic industries from the sites in the neighbouring areas, the Šalitrena Pećina Level 4 industry displays a much stronger affinity towards Central European industries (Mihailović, 2008), primarily to the material which originated from Level 9 at Willendorf II which, records numerous backed points, tools with retouched truncations and backed tools (Otte 1985; Otte *et al.* 1996; Valoch 1996). Parallels to Šalitrena Pećina can also be found at Gravettian sites in Hungary (Bodrogkeresztúr, Hidasnémeti, Nadap), which are associated to the Pavlovian tradition (Dobosi 2000; Lengyel 2016). All this could indicate that the populations that inhabited Šalitrena Pećina were closely connected with the Willendorfian and Pavlovian communities in the Pannonian Basin, or that the beginning of GI4 marked a movement of the Gravettian communities towards the south.

As with the Aurignacian, osseous production in the Gravettian in this part of Europe is still poorly known. Only a few sites in the Eastern Adriatic region and its hinterlands are chronologically assigned to the Late Glacial Maximum, or the period immediately preceding this dramatic climatic deterioration, and yielded bone implements (e.g., Šandalja in Istria; Badanj in Bosnia and Herzegovina; Vela Spila on the island of Korčula) (Karavanić 1999; Vukosavljević and Karavanić 2017). A thorough technological analysis of such an osseous industry is still not available (see Borić *et al.* 2020). In the south of the Italian Peninsula, at

Paglicci Cave, 24 osseous artefacts are documented in the Gravettian levels (from Level 23 to 18B) (Borgia *et al.* 2016, Mezzena 1975). Such an ensemble is primarily characterised by awls, some of which still have their articular epiphysis preserved. Perfectly symmetrical fusiform points, comparable in shape and dimensions to the ones documented in the Gravettian Level 4 of Šalitrena, appear at Paglicci only later, during the Early Epigravettian (Borgia *et al.* 2016), when also shouldered pieces are making their first appearance at the site.

At Šalitrena, during the Gravettian, long bones of large mammals continue to be chosen to produce perforating tools, such as points and awls. Awls are fragmentary yet documented in the Gravettian assemblage, while unfinished tools indicate that different phases of osseous *chaîne opératoire* were carried out at the site. Fusiform points are well-documented, and regular blanks used for their production of points were extracted and put in shape using techniques already documented at the site during the Aurignacian, i.e., longitudinal grooving and scraping. Functional modifications are developed on the Gravettian points because organic spearpoints can remain undamaged even after several impacts (Pétillon 2006). Interestingly, at Šalitrena, fusiform points are documented in association with shouldered pieces in the Gravettian levels (Mihailović 2008). Although shouldered points are mostly associated with the Early Epigravettian in Italy as well as in the Balkans, such tools appear in the eastern Adriatic region (e.g., at Vrbička cave in Montenegro) and in the Balkan hinterlands (at Šalitrena cave) already before 23kyr uncal BP (Borić & Cristiani 2016). The early association of shouldered pieces and fusiform points in the Gravettian horizons of Šalitrena would further sustain a hypothetical diffusion of hafting/hunting technological innovations, represented by the osseous points and shouldered pieces, from Gravettian cultures of central Europe as a possible adaptive response to climatic deterioration during the beginning of the Last Glacial Maximum, already suggested by Borić and Cristiani (2016). A bone shaft bearing developed traces of use as a wood wedge is of particular interest and indicates the use of expedient tools. Finally, two mammoth ivory artefacts document the processing of such material during the Gravettian at the site. Of particular interest is one fragmentary *plaquette,* which shows clear traces of controlled exposition to fire, carried out to give the object an even dark colour. Unfortunately, the fragmentary state of such an artefact does not allow the functional interpretation of the artefact.

Unlike the Gravettian sites, which are mainly grouped in the central parts of the Balkans, the LGM sites are concentrated mainly on the coasts of the Adriatic (Karavanić *et al.* 2015), Ionian and Aegean Sea (Darlas & Psathi 2016; Kaczanowska *et al.* 2010; Perlès 1987), indicating that there was an aggregation of the population during the LGM maximum in the Palaeo-Adriatic plain (Miracle 2007). Relatively modest lithic industries, with very limited repertoires of artefacts, have been recorded at the majority of these sites. Finds from Level 3 of Šalitrena Pećina testify to the very beginning of the technological decline that was recorded in the early Epigravettian of Southeastern Europe. A loss of technological complexity in the early Epigravettian probably could be related to local population extinctions during the advance of the LGM (Maier & Zimmermann 2017).

Conclusions

In summary, the data obtained in this research has provided a more expansive knowledge about the latest Neanderthal populations and the emergence of the early modern humans' presence in the central Balkans. Šalitrena Pećina has been proved to be a significant site to unravel the organisation of Mousterian, Aurignacian and Gravettian human groups in this particular region. The stable isotope signatures of the macromammals consumed by both human species provide the environmental conditions and changes that occurred at the time the site was occupied by humans, which mostly took place during interglacial stages (from the

GS11 to the end GI9 by Neanderthals, between the end of GS8 until GS6 by the Aurignacian and between the GI4 to the GS3 by the Gravettian groups). The technological studies indicate similarities to central Europe and Italian Gravettian assemblages. Furthermore, this is the first time that an Aurignacian and Gravettian bone industry of Serbia is documented in detail. Nevertheless, further survey and research on recently discovered and excavated Serbian sites will provide new information about this relevant period for human evolutionary studies.

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List of figures (captions)

Figure 5.1. Location of Šalitrena Pećina in Central Serbia and several views of the outside and front cave excavation area.

Figure 5.2. A: Radiocarbon dates for the Mousterian, Aurignacian and Gravettian assemblages of Šalitrena Pećina calibrated against IntCal20 in OxCal v.4.4, assuming each sample has a 5% prior probability of being an outlier within the general t-type outlier model. B: Chronological model of each cultural phase. Only ORAU dates have been obtained using the ultrafiltration protocol. Aoverall = 91.9. Modelled dates in Table 5.9.

Figure 5.3. Percentage of biomass estimates of the most commonly represented species in each archaeological level at Šalitrena Pećina.

Figure 5.4. Catchment areas for 1.2 and 2.15 hours walking distance from Šalitrena Pećina. A: Over topography B: Over terrain slope.

Figure 5.5. Representation of mammals in MNI for habitat biotopes across the Mousterian, Aurignacian and Gravettian in Šalitrena Pećina.

Figure 5.6. Examples of bone tools found in the Mousterian, Aurignacian and Gravettian levels at Šalitrena Pećina. 1-6. Retouchers (Mousterian); 7-11. Perforating tools and one proximal bevelled fragment (Aurignacian); 12-17. Pointed tools and blanks (Gravettian).

Figure 5.7. Technological and functional traces on osseous tools. Mousterian retouchers (a,b,c): (1-6) Superimposition of traces of damage (scores and pits).Aurignacian perforating tools (d,e) and proximal bevelled fragment (f): (7,8) longitudinal grooving; (9) longitudinal grooving; (10) functional modifications (rounding, compression) on the beveled artefact. Gravettian entire point (g) and proximal fragment of a point (h): (11) scraping marks; (12)

chat-marks and longitudinal grooving; (13) functional modifications (rounding, compression) on the beveled artefact.

Figure 5.8. The δ13C (left) and δ15N (right) values from the Mousterian, Aurignacian and Gravettian levels in Šalitrena Pećina.

Figure 5.9. Biplots of δ13C and δ15N Values for Bos/Bison sp., Deer, Horse and Ibex from the Mousterian, Aurignacian and Gravettian levels in Šalitrena Pećina.

List of tables (captions)

Table 5.1. Radiocarbon dates from Šalitrena Pećina. Calibrated dates and modelling results are given in Table 5.9.

Table 5.2. NISP, MNE and MNI values of the faunal assemblage from each archaeological level at of Šalitrena Pećina.

Table 5.3. Taphonomic information related to human and carnivore activity in each archaeological level at Šalitrena Pećina. Data are provided in percentages per level.

Table 5.4. Inverse Simpson Index results showing species diversity at Šalitrena Pećina calculated using NISP and MNI.

Table 5.5. α and β parameters for the different taxa species grouped by individual taxa or mammal size. MNE values lower than 40 must be considered with caution.

Table 5.6. Topographic areas in km2 and their percentage below and above 30% slope calculated for 1.2h and 2.15h walking distance from Šalitrena Pećina.

Table 5.7. Summary statistics for the Bos/Bison sp. bone collagen δ13C and δ15N values analysed at Šalitrena Pećina.

Table 5.8. Results from the bone collagen δ13C and δ15N isotopic analysis and quality indicators from faunal specimens analysed from Upper and Middle Palaeolithic Levels at Šalitrena Pećina.