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**Author:** Dogandzic, T.
**Title:** Techno-typological variability of the late Middle Paleolithic in the southern Balkans
**Issue Date:** 2021-06-23
CHAPTER 5

The Middle Paleolithic of the Balkans. An Overview of Industrial Variability, Human Biogeography, and Neandertal Demise

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Under Review at Journal of World Prehistory
ABSTRACT

An uneven record of Middle Paleolithic occupations characterizes Europe. Specifically, there is a marked difference for large parts of southeastern Europe with lower site densities and less intensive evidence of human presence. This has often resulted in the exclusion of the Balkans in the relevant debates related to Pleistocene human adaptation. This dichotomy stems either from the lower population densities of southeastern Europe or an imbalance in research across Europe. Additionally, our understanding of Balkan Middle Paleolithic stone tool industries suffers from the use of Mousterian labels defined when Bordian typology was the chief method of lithic analysis. Industrial facies then defined and still in use are Balkan Charentian, Levallois Mousterian, Micromousterian, Denticulate Mousterian etc. Then and still today their relation with the rest of the Eurasian record remains unclear. In this paper, we set aside the issue of scarcity of Pleistocene occupations and try to address addressing Neandertal biogeography, variation in their technological behavior, and their subsistence based on the available record. We review the current Middle Paleolithic record in the Balkans, present the seeming temporal and spatial trends, and present a provisionary biogeography of hominins, including scenarios for the demise of Neandertals at or soon after the arrival of modern humans in Europe. The paper ends with a discussion of perspectives for future research arising from this analysis of the available record and proposes some hypotheses regarding the role of the Balkans in the overall context of the occupational history of western Eurasia in the Middle/Late Pleistocene.

Keywords: Balkans, Middle Paleolithic, lithic industries, Neandertals, Homo sapiens, biogeography

5.1 INTRODUCTION

5.1.1 THE BALKANS AND THE MIDDLE PALEOLITHIC OCCUPATION INTENSITY

While Neandertals inhabited large portions of Eurasia including most of Europe, southwest Asia and east into Asia to the Altai, the archaeological record of their presence is not evenly distributed across this region. Certain regions, such as southwest
France, exhibit not only rich but a rather continuous presence of Neandertals. The Balkan Peninsula, as several other regions in Europe, lacks evidence of their continuous presence, either spatially or temporarily. The reasons behind the disproportionate density of the record across Eurasia may lay in a less intensive research history compared to other areas or in differences in occupational intensity in the Pleistocene or some combination of both, though most probably reasons vary between regions. For instance, the Pleistocene record may not be visible nowadays, as it has been suggested for some parts of eastern Europe where thick loess deposits cover potential Lower Paleolithic sites (Iovita et al., 2012; Romanowska, 2012).

Aside from factors that can alter the preservation through time of human occupations (Surovell et al., 2009), the incomplete and mosaic-like presence of Neandertal occupation throughout Eurasia may have several explanations. The biogeography of a population can vary with various factors related to climate, environment, topography, preference of settlement, existence of migration routes, etc. These, in turn, affect the demography of a population that may go through local extinctions or withdrawal and create specific spatial patterns across large regions with continuities and gaps in the record of human settlements. The combination of these factors, on a larger scale, creates the patchy character of the occupation record. The varied presence of Neandertals has been more intensively investigated in central, northern and north-western Europe (Gaudzinski-Windheuser and Roebroeks, 2011; Hublin and Roebroeks, 2009; Richter, 2016; Roebroeks et al., 2011; Wenzel, 2007), but some have taken a European-wide assessment (Davies, Valdes, Ross and van Andel, 2003; Richter, 2005, 2006). Occupational discontinuities are more distinct in the northern areas, which suggests that during climatic deteriorations hominins migrated from the north to southern areas and then re-colonized the north once the climate ameliorated. This model, called the ‘ebb and flow’ model, implies that population fluxes, in response to deteriorating climatic conditions, leave a distinct spatio-temporal pattern in the archeological record. However, it is possible that Neanderthals rather experienced a series of regional extinctions (Hublin and Roebroeks, 2009; Roebroeks et al., 2011), while other populations would have survived in the southern regions and persisted throughout the glacial periods. In either case, in many models parts of southern Europe,
including the Balkans, figure as favorable regions for habitation during climatic fluctuations and are expected to exhibit a rather continuous record (Dennell et al., 2011; Finlayson, 2008; Hublin and Roebroeks, 2009; Roebroeks et al., 2011; Serangeli and Bolus, 2008; Stewart, 2005).

For a large region, the Balkan peninsula has a low number of Middle Paleolithic locations, particularly sites with long and securely dated sequences, aside from a couple of known sites (e.g. Krapina, Vindija, Lakonis). Regardless of the reasons behind the sparse Pleistocene record, the region has insufficient information for understanding the adaptations of Pleistocene hominins. This seems as a paradox; if the Balkans is one of the southern refugia and if certain areas offer topographically and environmentally favorable conditions for habitations, why is the record so sparse? It is certain, however, that it merits further research, particularly if we consider its large area, and particular ecological and geographical position within Europe. In this context, several questions are apparent. Was the Balkans a region where ‘core’ populations occupied the area, particularly during the harsher climatic conditions, thus evidencing a continuous human presence, or did the Balkans host low population densities often devoid of human presence? Furthermore, given the climatic and geographical diversity of the peninsula, are there any correlations of these factors and human presence? Were Neandertal adaptations in this region, away from the ‘heartland’ of Europe in the west, somewhat different, relative to the Balkans’ geography, varied topography, climate, and paleoenvironment?

5.1.2 The Balkans and the Middle Paleolithic Industrial Variability

Typological classification systems were the initial tool for understanding variability in Middle Paleolithic material culture, and they gave rise to the early definitions of separate Mousterian varieties, mainly in southwest France (Bordes, 1953; Bordes and Bourgon, 1951; Mellars, 1965). For other regions within the geographic range of the Middle Paleolithic, the established nomenclature was accepted and sometimes new groups were defined. While Balkan Paleolithic researchers have generally adopted the western classification, there has also been a concern about whether these groups can be easily and appropriately applied to the regional record.
The past several decades of research into Middle Paleolithic lithic technologies has shown that typology is not an adequate reflection of different technological traditions and rather indicated instead differential tool reduction practices (Dibble, 1987, 1995). In this view, a large part of typological variability is related to how intensely sites have been occupied and resources utilized, as a response to changes in climate and environment (Rolland, 1977, 1981; Rolland and Dibble, 1990). This work, along with the work of technological school in France, helped shift the field away from tools types to a greater emphasis on technology of blank production in assemblage interpretations. Technological repertoire of Middle Paleolithic material culture consists of diverse methods of blank production: e.g. Levallois, discoidal, bifacial, Quina, and various core on flake methods (Boëda, 1993, 1994; Bourguignon, 1997; Delagnes et al., 2007; Peresani, 2003; Tixier and Turq, 1999; Turq, 1989) and the prominence of one over others led researchers to group them into Mousterian variants (e.g. Delagnes et al., 2007). This research continues today with the re-definition of groups and the addition of new groups this time based on predominant technological methods. Balkan Paleolithic archaeology, however, lagged behind these interpretative changes. It did not fully adopt the research transformation from a typological to technological basis for the definition of technocomplexes or the recognition of other factors affecting assemblage variability. When Paleolithic research in Europe almost abandoned the terms Typical and Charentian Mousterian, the Balkans archaeology was coping with the applicability of these terms to the regional record. Moreover, it still needs further work to deconstruct the typological groups and factor in various aspects that influence the assemblage variability.

Setting aside a consideration how the different Middle Paleolithic techno-complexes are defined, variation in Neandertal technological behavior is potentially patterned at both temporal and regional scales (Discamps et al., 2011; Jaubert, 2010; Monnier and Missal, 2014; Pettitt, 2003; Richter, 2000; Ruebens, 2013; Thiébaut et al., 2014). For instance, prismatic blade assemblages are particularly common in MIS 5 in northern Europe (Delagnes, 2000; Koehler, 2011; Révillion, 1995; Tuffreau and Révillion, 1995), while on the other hand there is still some debate about how chronologically constrained technologies like Quina (Discamps et al., 2011; Guérin et al., 2016; Guibert
et al., 2006; Le Tensorer, 1978; Morin et al., 2014; Daniel Richter et al., 2013) or bifacial (Monnier and Missal, 2014; Richter, 2016; Ruebens, 2013) are. Some have argued that the patterning in lithic industries in southwest France is responding to changes in climate and environment. Whether the industrial variability in the Balkans is similarly patterned is a question that can be answered only after the record id brought up to date.

Besides being a potential refugium for Neandertal populations, the Balkans is noteworthy for its position at the entrance to Europe from southwest Asia and from the Eurasian steppes to the north and east. The region represents a transit zone and can provide a valuable record on patterns of dispersals, timing, routes, and possible hominin interactions (Fu et al., 2015). In this regard, an open question is Neandertals’ longer persistence in this region than in other areas of Europe and a question of whether their demise is associated with climatic factors or with incoming modern humans. Regarding the latter, what scenarios can be envisioned for the population replacement in this region that modern humans entered from southwest Asia prior to reaching central Europe?

Given these many questions, this review attempts to present the current Middle Paleolithic (MP) record from the Balkans and our understanding of Pleistocene hominin adaptations, with a particular emphasis on the variability of their technological behavior and population history apparent from the available record. While recent and on-going research in the Balkans is conducted in many countries, an overview of the available record is so far missing. The patchiness of the Paleolithic record of Europe, and certainly of the Balkans, is to a certain extent a result of research conducted with different political attentiveness to science and of the international connectedness of any given country (Gamble, 1986). Most reviews tend to cover the record within the political borders of a particular country (Darlas, 2007a; Ivanova and Sirakova, 1995; Karavanić, 2004, 2007; Tourloukis and Harvati, 2017). Here instead we try to adhere to geographical parameters and to incorporate the region of the Balkan peninsula.

In our review of the MP record, we follow a geographic rather than political definition of the region, and consider topographic and environmental parameters of relevance to Pleistocene human occupations. In our case, however, this approach
would oblige us to review the record north of the Danube and Sava, i.e., Romania, Hungary, and northern parts of Serbia and Croatia usually considered part of the Balkans, because it constitutes the same environmental and topographic zone as the northern parts of the Balkan Peninsula, including the wide valleys of Danube and Sava. While we will refer to the MP record of these areas, we will, nonetheless, not thoroughly present this area in our review and keep within the accepted limits of the peninsula. This might, for instance, leave out the important site of Vindija. Wide river valleys in the north are relevant for human migrations, and the record from this region will be accounted for in the discussions of early modern human dispersal into Europe.

We begin with a geographical, paleoecological, and paleoclimatic review of the region that sets the scene for examining human occupations and adaptations in the sections that follow. With the vast region that the Balkan peninsula covers, subregional variation in landscapes and climate may be crucial for understanding the adaptations and particularly the migrations of past populations. To get a better picture of the variability of MP industries and how they change through time, we chose to review the record chronologically rather than by techno-complex. While we are fully aware of the palimpsest problem in the archaeological record (Bailey, 2007; Holdaway and Wandsneider, 2008; Stern, 1994) and finer resolution is seldom realistic (Aldeias et al., 2012; but see McPherron et al., 2005; Rezek, 2015), we are still interested in observing the variability within time periods of more or less similar climatic conditions, i.e. Marine Isotope Stages (MIS).

While a chronological approach to the regional record is preferred in this case, it is also true that this approach is challenging given the relative lack of chronological information and absolute dating for many key sites. Chronological framing of assemblages has often been done based on stratigraphy and geology with the help of climatically sensitive faunal species. Therefore, this review will be primarily based on sites with reliable chronological estimations and to a somewhat lesser extent on stratified sites where some temporal trends in technology are possible to observe but assemblages cannot be chronologically constrained. Available radiometric ages are presented in Supplementary Tables.
In addition, it should be mentioned that many assemblages come from collections excavated during the early 20th century and analyzed with outdated methods. Lithic data was collected with variable methods, and with incomplete data, for instance, usually only information relevant for the F. Bordes method is available. A technological analysis, aside from the Bordian calculations of Levallois index (e.g., Ivanova, 1979) is often missing. There are some early attribute analyses (e.g., Sirakov, 1983), though many assemblages have not been subjected to recent re-analysis. Therefore, many inconsistencies in the way industries are reviewed here is a result of the non-standardized way these assemblages have been analyzed and reported. A final caveat is that a consistent pattern for MP sites from the Balkans is that they represent evidence of ephemeral occupations with assemblages too small for clear patterns in lithic technology to be expressed.

5.2 Geography and Palaeoenvironment of the Balkans

5.2.1 Geography of the Balkan Peninsula

The Balkan peninsula is often thought to coincide with a geographical region of Southeastern (hereafter SE) Europe. The two terms are used interchangeably and the latter has been widely used over the former in the last decades, so as to avoid historical, political, and cultural connotations (Todorova, 1997). The Balkan peninsula is, nevertheless, a part of SE Europe. SE Europe, as a political region of Europe, consists of the following countries whose territories are fully or partially included here: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Moldova, North Macedonia, Montenegro, Romania, Serbia, Slovenia, and Turkey. The Balkan peninsula, on the other hand, can be defined by its topographic boundaries: the rivers Danube, Sava and Krka (Cvijić, 1922) to the north and the Adriatic, Ionian, and Black Seas as its marine boundaries in the west, south and east (Reed et al., 2004) (Fig. 1).
Characterized by varied topography and climate, the Balkan Peninsula is broadly divided into three main geographical zones: Mediterranean zone, mountain chains and northern lowlands (Furlan, 1977; Reed et al., 2004). Almost 70% of this territory is high relief of the large mountain chains of Dinarides and Balkan-Carpathian mountains transcending from the east to the west of the peninsula, then Rhodopes in
the east and Pindus in the southern Balkans. These mountain chains run from the coasts of the Adriatic, Ionian and Aegean Seas and clearly separate the Mediterranean geographic and climatic region from the northern plains (Fig. 1). As such, they represent natural barriers and are rarely intersected by broad river valleys. Exceptions to this are the Maritza river basin in the southeast of the peninsula (European part of Turkey and Bulgaria), running from the very entrance to the Balkans from Anatolia towards the central areas of the peninsula, and the Vardar river valley from northern Greece leading to the Morava river valley in Serbia. Several potential passageways from the Sava valley southwards to the northern Adriatic coast may have been possible. These represent south to north routes across the peninsula, though the high mountains might have impeded migrations in this direction. The wide valleys of Danube and Sava rivers represent a major east-west route across the peninsula, along its northern borders, connecting Eastern Europe with the Central European plain.

In the north of the peninsula, the southern edges of the great Pannonian Plain meet the gently sloping mountains in an area of low hills. Major wide river valleys running to the south represent the extension of the Pannonian Plain and its southernmost parts, laying at less than 200 m asl (Čalić et al., 2012). The lowlands include the Middle and Lower Danube Basin, their limit being the Iron Gates gorges on the Serbia-Romania border. This is the topographic and environmental transitional zone between the mountain ranges and the Pannonian basin and is comparable to other 'overlap' zones in Europe between northern and southern regions (Davies, Valdes, Ross and van Andel, 2003; Stewart, 2005), all characterized by greater ecological diversity. The widest lowland area is the large Danube valley and its main tributaries, Velika Morava, and Sava with its own tributaries in Bosnia and Croatia. Along the Mediterranean coast, to the contrary, mountains rise more steeply than in the north, leaving no wide valleys towards inland, at least not in the present day. The coast, nevertheless, has had a more fluctuating coastline throughout the Pleistocene and even more dramatically along the northern Adriatic. Additional migration corridors along the Mediterranean coast have been created once the landscape changed with the formation of a large land mass connecting Asia Minor and Greece (Tourloukis, 2010).
5.2.2 THE BALKANS AS A REFUGIUM

The Balkan peninsula, along with two other southern European peninsulas, the Iberian and the Apennine, is a refugial region where flora and fauna, particularly temperate deciduous forests and its biota, existed during the full-glacial conditions (Bennett et al., 1991; Eastwood, 2004; Hewitt, 2000; Miracle et al., 2010; O'Regan et al., 2002; Stewart et al., 2010; Tzedakis, 2004; Tzedakis and Bennett, 1995; Weiss and Ferrand, 2007; Willis, 1994). The southern refugia were a source of expansion and re-colonization for many species of plants, insects and vertebrates in central and northern Europe (Hewitt, 1999, 2000). Several philogeographic studies have shown that species expand their ranges from the southern peninsulas of Europe at the end of the ice ages when more favorable climatic conditions commenced and that northern populations derive from these Mediterranean 'refugial' populations (Hewitt, 1999, 2000).

The success of the re-colonization, nevertheless, depended on the extent to which the mountain ranges represented barriers for the species concerned (Hewitt, 1996, 1999). High altitude mountain chains of the Alps and the Pyrenees, above 2000m, could have impeded the migrations northwards from the southern refugia. As for the Balkans, temperate species existed in the forested areas along the Mediterranean coast (Adriatic coast, along Greece and European Turkey), and the movement towards the north required passing mountains over 1000 m, less of an impediment than the Alps or the Pyrenees (Hewitt, 1996). Genetic studies of several species of small mammals demonstrated that these populations failed to expand and remained in geographical isolation in the Mediterranean peninsulas. As such, these Mediterranean regions were, for some species, 'hot spots' for endemism rather than a source of their re-expansion; this is the case for small mammals and numerous plant species (Bilton et al., 1998; Stewart et al., 2003; Stewart and Lister, 2001). Species capable for crossing the mountain range, such as bears, could have easily migrated out of southern refugia. Compared to northern Europe, southern areas, including the Balkans, are characterized by greater biodiversity and endemism for both plant and animal species (Griffiths et al., 2004).

This may have been true for human populations as well, where 'core' populations not necessarily retracted to but survived in southern refugia during the glacial periods
As populations outside of this region went through local extinctions (Hublin and Roebroeks, 2009; Roebroeks et al., 2011), the survival of the species would have depended on their persistence in South and Southeast Europe, similar to the case of plant species (Dennell et al., 2011). Potentially, the Balkans may have been one of the major core areas of settlement for hominin populations (Dennell et al., 2011, p. 1522). In terms of the archaeological record, if this region was a glacial refugium, it should be demonstrated that it was populated during cold, glacial phases, otherwise it has to be considered as a region of peripheral settlement (Dennell et al., 2011; Stewart et al., 2010; Stewart and Stringer, 2012). This said, the Balkan peninsula, with its diverse topography, refugial character and as a transit zone between eastern and central Europe, potentially acted both as a migration corridor and cul-de-sac (Kozłowski, 1992) for hominin populations.

5.2.3 Pleistocene Environment and Climate

The peninsula falls in the temperate zone between 35 - 48N latitude. With three geographical zones, it exhibits different climatic features across its territory, but overall it is broadly continental. With W-E transcending mountain ranges, warm air masses cannot reach the northern lowland area. Likewise, the Mediterranean part is sheltered from continental winters from the north. European continental, Mediterranean, Atlantic and central Asian climatic systems all affect variation in the climate of SE Europe (Ducić and Radovanović, 2005; Furlan, 1977). Hence, the climatic and environmental history of the region was susceptible to the relative influence of these competing systems (Stevens et al., 2011). In general, the mountain region is characterized by an Alpine climate, the northern plains by a continental climate similar to central Europe, and the southern coast by a Mediterranean climate (Furlan, 1977).

Pleistocene climate and environmental reconstructions of the Balkans are possible given the extensive existing research in several fields:

a) The Southern Balkans provided exceptional records of well-known pollen sequences in lacustrine contexts that span several glacial cycles: Tenaghi Philippon
b) Northern regions of the peninsula are part of the Danube river drainage system, and contain thick loess-paleosol deposits that preserve a valuable record of past environments (Marković et al., 2012; Marković, Fitzsimmons, et al., 2015; Marković-Marjanović, 1968; Smalley and Leach, 1978; Vasiljević et al., 2011). The importance of the Danube loess belt was recognized early (Marsigli, 1792), and intensive research has provided one of the most complete European terrestrial paleoclimatic records enabling the construction of a regional stratigraphic model as well as comparisons with models coming from other European and Chinese loess-paleosol sequences (Marković et al., 2012; Marković, Stevens, et al., 2015). A continuous record of alternating aeolian and pedogenetic depositions has an excellent preservation potential due to a rather stable deposition on loess plateaus. They are numerous in the Serbian part of Panonian basin, where some loess deposits reach even 40 m in thickness, such as at Stari Slankamen (Marković et al., 2011) and Batajnica (Buggle et al., 2008, 2009; Marković et al., 2009). Loess deposits extend even south into the inland of the peninsula at the sites of Belotinac (Basarin et al., 2011) and Stalać (Obreht et al., 2016), along the Morava river valley in Serbia. In the Dobrogea region of southeast Romania, the Danube River delta loess-paleosol deposits reach 30 m or more, e.g., Mircea Voda (Buggle et al., 2008, 2009; Fitzsimmons et al., 2012). The same depositional thickness is encountered in several locations in Croatia (Galović et al., 2009; Wacha et al., 2013) and Bulgaria (Jordanova et al., 2007; Jordanova and Petersen, 1999). Studies in paleopedology, malacology, magnetic susceptibility, geochemistry, and luminescence dating have provided a significant contribution to paleoenvironmental reconstruction.

c) Mountains in Croatia (Marjanac and Marjanac, 2004), Montenegro (Adamson
et al., 2014, 2016; Djurović, 2009; Hughes et al., 2010, 2011; Petrović, 2014), Greece (Adamson et al., 2014; Hughes et al., 2007; Hughes, Woodward, Gibbard, et al., 2006; Woodward et al., 2004), eastern Bosnia (Milivojević, 2007), the border between Serbia and Albania (Menkovic et al., 2004) (Milivojević et al., 2008), and Slovenia (Bavec et al., 2004; Ferk et al., 2015) bear evidence of glaciations during multiple glacial cycles and are another valuable paleoenvironmental record, while the Bulgarian highest mountain range holds evidence only of the LGM glaciation (Kuhlemann et al., 2013).

The most comprehensive data come from the mountains of NW Greece where reliable geochronological data have been obtained (Mount Tymphi, Olympus, Pindus) which allow for a correlation with the nearby pollen records (Hughes, Woodward and Gibbard, 2006; Hughes, Woodward, Gibbard, et al., 2006; Hughes and Woodward, 2006). Regardless of the fact that the pioneering work on glaciation and glacio-karstic landscape was initiated in the Balkans (Cvijic, 1900, 1917; Cvijić, 1899, 1903a, 1903b), in many areas of the peninsula, in fact outside of Greece, this research is still not in advanced stages and lacks well-dated glacial and periglacial sequences. This hampers obtaining a clearer picture of the history of glaciation in the central and southern Balkans (Hughes, Woodward, Gibbard, et al., 2006).

**Paleoclimatic reconstructions.**

**Late Middle Pleistocene**

**Glacials:** MIS 12 (478-424 ka BP) marked a major glaciation in northwestern Europe and the Alps and was one of the coldest stages in the Balkans as well. In fact, the most extensive glaciation recorded in the Mediterranean region of the peninsula comes from MIS 12 (Adamson et al., 2014, 2016; Hughes et al., 2007, 2010, 2011; Hughes and Woodward, 2008). During this time, all of the conjoining ice-caps in central Montenegro were spread over an area of 1500 km², thus representing one of the largest and lowest ice caps in the Mediterranean (Hughes et al., 2010). Some of the lowest glaciers in the Balkans were located on the Dalmatian coast in Croatia, some of them reaching at least 90 m asl and probably even at the sea level or below (Marjanac and Marjanac, 2004, 2016). Major glaciations in the Dinarid mountains have been recorded for MIS 12, and MIS 6, though there is possible evidence of another, smaller, glaciation.
in central Montenegro prior to MIS 7, i.e. in MIS 8 and/or MIS 10 (Hughes et al., 2011). In the north of the peninsula, starting from MIS 8 (~300 ka), loess accumulation rates increased in the southern Pannonia, and a more steppic and relatively more arid environment developed there (Buggle et al., 2009; Fitzsimmons et al., 2012; Marković et al., 2011).

During the penultimate glacial, i.e. MIS 6 (191-130 ka BP), the Balkans, like the rest of the Europe, witnessed very intense, unfavorable climatic conditions. Precipitation from the Mediterranean sea did not extend to the interior of the peninsula, and this lack of humidity led to extremely dry conditions (Obreht et al., 2016). This glaciation was less extensive, however, in its extent and volume than the most extensive glaciation the region witnessed in MIS 12, and no larger scale glaciations in the Dinarid Alps have occurred since MIS 6 (Adamson et al., 2014, 2016; Bavec et al., 2004; Hughes et al., 2007, 2010, 2011; Hughes and Woodward, 2008; Marjanac and Marjanac, 2004; Woodward et al., 2004).

The climate of the cold stages during the Middle Pleistocene was dry and cold, but the eastern Mediterranean still had a sustained moisture supply. This humidity, however, could not reach inland Balkans because of the ice caps in the Dinarides, hence this area maintained dry conditions (Hughes et al., 2010) and the forests contracted (Tzedakis et al., 2006). The glacial in the southern regions characterized by open grass vegetation and very low pollen concentration of *Pinus* and *Juniper* species (Sadori et al., 2016; Tzedakis et al., 2003). Some parts of the Balkans had higher precipitation and fewer temperature fluctuations that favored the survival of temperate tree species (Bennett et al., 1991; Tjeerd H. van Andel and Tzedakis, 1996), but their distribution varied in a north-south direction. Coniferous trees were represented in the northern areas with deciduous trees further south and evergreen forests on the coast (Bennett et al., 1991; Tjeerd H. van Andel and Tzedakis, 1996).

The greater extent of the ice lowered sea level during Middle Pleistocene glacial to a similar degree as during MIS 2, probably not more than 120 m (Tjeerd H. van Andel and Tzedakis, 1996), and substantially changed the coastal environment in the Mediterranean region by creating large plains and river valleys. As it has been
reconstructed for the Late Glacial Maximum, water retraction in the Adriatic Sea exposed the large continental shelf and formed a wide open plain that linked the Apennine and Balkan peninsulae (Maselli et al., 2011, 2014). Rivers running from the Alps provided rich water resources and hosted abundant large migratory animals (Schackleton, 1984). Similarly, the Pinios and Axios Rivers in northern Greece and the plains of the western coast of Albania formed plains larger than they are today, while at the retraction of least half of the Aegean Sea formed large land in the glacial periods, with extensive drainage systems, plains, and lakes (Lykousis, 2009).

**Interglacials**: The pollen record from the south shows that MIS 11 (424-374 ka BP) was a warm and extensive interglacial, clearly the warmest interglacial in the last 600ka years (Tzedakis and Bennett, 1995). In the loess-paleosol sequences in Vojvodina, this stage is marked by an unexpectedly weak paleosol development, a surprising finding for a stage considered to be a long interglacial (Marković et al., 2011). The record, however, suggests very warm and wet conditions during MIS 9 (337-300ka BP) that did not reoccur in the subsequent interglacials (Buggle et al., 2008, 2009). Starting from this stage, the Middle and Lower Danube Basins are characterized by the progressive aridization of the interglacials during the Middle Pleistocene, most likely as an outcome of the surface uplift of the Dinarids, Carpathians, and the Alps (Buggle et al., 2013; Marković et al., 2011). Interglacials in the Middle Danube Basin in the last 350 ka have continental climate and steppe or forest-steppe environment (Marković et al., 2012). The central areas of the Balkans remained outside of the influence of the Middle Danube basin and bear evidence of a more pronounced influence of the Mediterranean climate in MIS 9 and 7 (Buggle et al., 2008; Obreht et al., 2016). This influence, however, progressively diminishes; starting from MIS 7 each interglacial was less warm than the previous one, suggesting an increased influence of the continental climate in the central areas of the peninsula at least (Buggle et al., 2008; Obreht et al., 2016). The pollen records show some fluctuations during MIS 7 and overall colder conditions than the subsequent MIS 5e interglacial (Roucoux et al., 2008).

**Upper Pleistocene**

The Last Interglacial, MIS 5e (130-115 ka BP, the Eemian), was less warm and
humid than the previous interglacials, and, in the central Balkans, this was the first interglacial characterized by a more continental climate (Obreht et al., 2016). Overall, since the beginning of the Late Pleistocene, the influence of Mediterranean climate in the interior of the Balkans is less pronounced and more continental conditions prevail. The climate in the northern valleys was nonetheless warm and humid, characterized by a moderate to warm steppe environment, probably forest-steppe, based on intense pedogenesis in the loess-paleosol deposits and the intensely weathered steppic soils (Fitzsimmons et al., 2012; Marković et al., 2004, 2011). The influence of Atlantic air masses brought westerly flows and wetter maritime air masses in the region (Stevens et al., 2011).

In the Mediterranean, however, it was the warmest interglacial in the last 450 ka years (Abrantes et al., 2012) but with smaller scale variations (Tzedakis et al., 2003). At the onset of the Eemian sea levels rose, even up to 9 m higher than today (Dutton and Lambeck, 2012; Gallup et al., 1994; Kaufman, 1986), drastically changing the coastal topography in the Mediterranean. Sea level rise during warmer periods would have reduced the productive eco-zone, particularly in the Adriatic, resulting in diminishing migratory species (Shackleton et al., 1984; van Andel and Shackleton, 1982). Interglacial vegetation spread out of the refugial zones in the south across the rest of the continent. The southern regions of the Balkans would have abundant oak (Quercus), elm (Ulmus/Zelkova), Mediterranean olive (Olea) and evergreen forests (T. H. van Andel and Tzedakis, 1996).

The interglacial climate started to deteriorate with the onset of the Early Glacial, MIS 5d-5a (115 – 71 ka BP). In the northern Balkans, accumulation rates of loess deposits of the last glacial cycle were more substantial than in earlier periods (Fitzsimmons et al., 2012; Marković et al., 2008; Stevens et al., 2011). In the central Balkans the shift from Last Interglacial to Last Glacial was nevertheless mild, and conditions during the early and late Last Glacial were rather mild and humid (Obreht et al., 2016). In northern Bosnia and Herzegovina, at the sites of Visoko Brdo and Kadar, in deposits associated with Mousterian artifacts, pollen samples show a dominate tundra-grassland environment with sporadic dwarf birch, juniper, and pine (Gigov, 1973; Montet-White and Johnson, 1976). In the vicinity of springs and rivers there may have been small
stands of dwarf willow and alder. In the absence of radiometric dates at sites with pollen records, it is not possible to make a correlation with the MIS stages, but sites with corresponding industries are dated to MIS 5d-a.

In the Dinarid mountains, however, only smaller glaciers developed during MIS 5d to MIS 2, which facilitated the movement of warm and humid air into the interior of the peninsula from the Mediterranean (Hughes et al., 2011). The last glacial in general had warmer summer temperatures compared to Middle Pleistocene glacials, higher annual precipitation, and more humid summers (Hughes et al., 2007). On the south, according to pollen records, Mediterranean parts of the peninsula were covered in closed evergreen, deciduous and mixed forests and had warmer and wetter climates (Panagiotopoulos et al., 2014; T. H. van Andel and Tzedakis, 1996).

At the culmination of the glacial during MIS 4 (71 – 57 ka BP) a substantial increase in loess accumulation in the northern plains was triggered by the cold conditions. The boundary between the paleosol and loess deposition recorded at several sites is rather sharp and relates to an age of 75 ka BP (Marković et al., 2008). The northern plains and river valleys of the Danube Basin had a dry glacial climate, with alternating windy and less windy phases and with less influence from Atlantic or Mediterranean moisture (Stevens et al., 2011). According to the loess records, MIS 4 and MIS 3 environments in this region were characterized by grassland with trees still preserved in the river valleys, and the whole last glacial in the south Carpathian region was a dry and relatively warm glacial period (Marković et al., 2004, 2008).

In the south, the onset of MIS 4 saw a contraction of warm-loving tree populations into the southern refugia, and most central and southern areas of the peninsula were characterized by an open landscape, wooded-steppe with pine dominating and rare oak species. Temperatures and moisture availability declined, and cold and dry conditions prevailed (Panagiotopoulos et al., 2014).

MIS 3 (57-29 ka BP) evidenced a return of the forest with a warm and humid climate. This period was characterized by climatic instability with short-term, extreme oscillations such as Heinrich events (hereafter HE) (Heinrich, 1988; Hemming, 2004)
and Dansgaard-Oeschger (D-O) cycles of rapid warming and gradual cooling. These have been detected in both marine and terrestrial records reflecting millennia-scale variability in the climate of the North Atlantic (Dansgaard et al., 1993; Heinrich, 1988; Sánchez Goñi et al., 2000). Lake sediment records in the southern Balkans preserve these changes as well (Tzedakis et al., 2004), though not with the same effect and with much local variation. In areas with less precipitation (e.g., eastern Greece, Thenaghi Phillipon) these phases were more severe than in western areas (NW Greece, Ioannina) with higher precipitation. Higher tree densities existed only in these moist areas (Tzedakis et al., 2004; Tjeerd H. van Andel and Tzedakis, 1996). The woodland in the south of the peninsula was, however, of open character, with temperate trees, scattered pine, oak, and other deciduous trees (Panagiotopoulos et al., 2014). Overall, the wider region of SE Europe featured a vegetation of temperate grassland, temperate deciduous forest, temperate woodland, and evergreen taiga/montane forest during MIS 3 with a vegetation of evergreen taiga/montane forest and temperate woodland in the northwestern Balkans (Huntley and Allen 2003).

In the loess-paleosol sequences, however, during MIS 3, paleosols developed as single, double or multiple pedocomplexes, with loess sublayers evidencing cooling and aridity. Overall the period was rather warm and moist with no cryogenic features recorded, unlike in sequences in central and eastern Europe (Marković et al., 2008). In the same zone, in the south of the Pannonian plain, the sites of Vindija, Velika pećina, and Veternica provide faunal evidence on mammalian species that indicate broadly temperate conditions during MIS 3 with a range of environments (open, forested, wetland, and rocky), although there was probably less forest cover than today (Miracle et al. 2010).

How extreme were these climatic fluctuations in the Balkan peninsula during the MIS 3? As testified by the Prespa and Ioannina pollen records, climatic and environmental conditions during the HE 5 event (ca. 48 cal BP) were less severe than in the North Atlantic (P. C. Tzedakis and Tzedakis, 1994; Panagiotopoulos et al., 2014; Wagner et al., 2010). It is thus possible that at least in the south of the peninsula, conditions remained favorable during MIS 3. In the north, loess deposits in the Middle Danube region do not contain a consistent record of all Heinrich events during MIS 3.
(Stevens et al., 2011), suggesting that their effect was a lot less than in western Europe (Fitzsimmons et al., 2012; Stevens et al., 2011).

Conditions, however, might have been more dramatic during HE 4. The Campanian Ignimbrite (CI) volcanic eruption in the Phlegraean fields, at 40ka BP, resulted in deposition of the Y5 tephra at many locations in Italy and SE Europe (Fedele et al., 2003, 2008; Giaccio et al., 2006, 2008; Pyle et al., 2006). Of all Heinrich events, HE 4, which immediately followed the CI eruption, had the greatest effect on vegetation according to the Prespa (Panagiotopoulos et al., 2014) and Ioannina (Lawson et al., 2002; Tzedakis et al., 2003, 2004) records. These illustrate the extent of impact this volcanic eruption had on climatic changes in the following period. The proximity and the magnitude of the eruption probably had a significant detrimental effect on the ecosystem of the Balkans (Fedele et al., 2008; Fitzsimmons et al., 2013; Giaccio et al., 2008; Lowe et al., 2012). As evidenced by the thick Y5 tephra records, the lower Danube basin along with regions of the eastern and to some extent the central Balkans were all severely affected by HE 4 (Fitzsimmons et al., 2013; Obreht et al., 2016).

In sum, the Balkan peninsula is broadly divided in three main geographic zones: southern Mediterranean zone, central mountain chains, and northern lowlands, and characterized by the corresponding climatic zones, Mediterranean, continental, and temperate. Southern regions had most favorable conditions and provided a refugium for flora, though not in its entire area as some areas did evidence tree retraction in colder phases. Mountain chains went through a series of glaciations during glacial periods, with the last one happening during MIS 6 and with milder conditions characterizing the Last Glacial. The northern Balkans plains, the westernmost part of the Eurasian steppe belt, were never fully glaciated nor experienced tundra conditions but were characterized by open steppe conditions and sparse trees.

5.3 Middle Paleolithic Record and a Brief Research History of Lithic Industries

The Balkan peninsula abounds with caves and rock shelters owing to the carbonate geology of the extensive mountain chains that led to the development of
karstic forms. Mountains in the Balkans, offering some of the most famous karstic regions in the world, unquestionably merit further explorations for Paleolithic sites. In addition to the sedimentary records of caves and shelters, some MP occupations have also been documented in open-air sites. The southern extensions of the Pannonian plain contain thick loess-paleosol deposits, but very few sites with remains of human occupations. To the contrary, in Northern Bosnia over 100 Paleolithic sites have been discovered along river terraces at 100-300 m asl in loess-like deposits interstratified with paleosols, though not many have been investigated archaeologically (Basler, 1963; Jovanović et al., 2014). Lithic material from these terraces, the only evidence of Paleolithic occupations, more often than not contains artifact attributable to both Middle and Upper Paleolithic due to stratigraphic mixing of levels resulting from the extensive erosion. In Bulgaria, a small number of open-air sites is known, but noteworthy are instances of high-altitude surface assemblages in a context of raw material outcrops (Ivanova, 1994; Ivanova and Sirakova, 1995). Out of 240 MP sites in Greece, almost 90% of them are of open-air character, and only a few have been systematically excavated (Elefanti and Marshall, 2015). The scarce record of the Albanian Paleolithic consists primarily of surface collections (Runnels et al., 2009). Drastic sea-level changes in the northern Adriatic left many Pleistocene sites from the glacial times submerged; in that light, a recent discovery of underwater sites with MP artifacts is an exceptional finding (Karavanić et al., 2014).

Paleolithic research in the Balkans is characterized by long, though intermittent, work that has focused on extensive surveys, intensive interdisciplinary endeavors, and evaluative research on lithic industries. The history of research is presented in many publications (e.g., Mihailović, 2014b; Papagianni, 2000) and follows different research trajectories per each country; therefore, we will not engage in compiling an extensive history of discoveries and investigations but rather concentrate on the previous assessments of industrial variability. The sites mentioned in this paper that are deemed the most informative for this review are listed in Table 1. Supplementary Table 1 lists available radiometric ages for MP levels at the Balkans sites. These data are graphically represented on Fig. 2. Unfortunately, most sites in the Balkans lack absolute dating, and many have only radiocarbon ages that need to be considered as minimal ages. For most
sites excavated in the mid- or late 20th century, no absolute dating is available, but the character of the sediments and an analogy with other sites could provide a tentative chronological placement of assemblages. More often than not, this assessment usually points to a Last Glacial age. At times some chronological indications based on fauna and/or microfauna or stratigraphic positions have been made, though these are typically without sufficient certainty. For stratified sites, however, it is at least possible to evaluate temporal trends of technological variation.

**Table 1:** List of the archaeological sites considered in this review, with their abbreviations as used in the figures, and main bibliography.

<table>
<thead>
<tr>
<th>Site</th>
<th>Abbreviation</th>
<th>References:</th>
</tr>
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<tbody>
<tr>
<td>Bacho Kiro</td>
<td>BK</td>
<td>(Drobniewicz et al., 1982; Kozłowski, 1982; Mook, 1982; Tsanova, 2008b)</td>
</tr>
<tr>
<td>Bioče</td>
<td>Bi</td>
<td>(Derevjanko et al., 2012; Dogandžić and Đuričić, 2017; Đuričić, 2006; Ђуричић, 1997)</td>
</tr>
<tr>
<td>Crvena stijena</td>
<td>CS</td>
<td>(Baković et al., 2009; Basler, 1975a; Dogandžić and Đuričić, 2017; Mihailović and Whallon, 2017; Morley, 2007; Morley and Woodward, 2011; Whallon, 2017)</td>
</tr>
<tr>
<td>Hadži Prodanova pećina</td>
<td>HPP</td>
<td>(Mihailović, 2008; Mihailović and Mihailović, 2006)</td>
</tr>
<tr>
<td>Klissoura</td>
<td>Kl</td>
<td>(Koumouzelis et al., 2001; Kuhn et al., 2010; Sitlivy et al., 2007, 2008; Starkovich, 2014, 2017; Stiner et al., 2007)</td>
</tr>
<tr>
<td>Kalamakia</td>
<td>Km</td>
<td>(Darlas, 2007b; Darlas and de Lumley, 1999; De Lumley et al., 1994; Harvati et al., 2013)</td>
</tr>
<tr>
<td>Krapina</td>
<td>Kr</td>
<td>(Frayer, 2006; Gorjanović-Kramberger, 1906; Rink et al., 1995; Simek, 1991; Simek and Smith, 1997)</td>
</tr>
<tr>
<td>Klčevica</td>
<td>Kv</td>
<td>(Karavanić et al., 2014, 2017)</td>
</tr>
<tr>
<td>Kozarnika</td>
<td>Kz</td>
<td>(Guadelli et al., 2005; Sirakov et al., 2010; Tsanova, 2008b)</td>
</tr>
<tr>
<td>Lakonis</td>
<td>Lk</td>
<td>(Elefanti et al., 2006; Harvati, 2003; Panagopoulou et al., 2004; Richards, 2008)</td>
</tr>
<tr>
<td>Mala Balanica</td>
<td>MB</td>
<td>(Mihailović, 2009b; Rink et al., 2013; Roksandic, Mihailovi??, et al., 2011)</td>
</tr>
<tr>
<td>Mujina pećina</td>
<td>MP</td>
<td>(Karavanić et al., 2008; Karavanić and Golubić, 2008; Miracle, 2005; Rink et al., 2002)</td>
</tr>
</tbody>
</table>
Early syntheses and classifications of MP industries were carried out in the 1970s by M. Gabori (Gabori, 1976), J. K. Kozłowski (Kozłowski, 1975), and S. Ivanova (Ivanova, 1979). Excavations at several significant locations were either finalized or in progress at that point (e.g. Krapina, Vindija, Crvena stijena, Asprochaliko, Londa, Kamen, Samuilitza, Mouselievo, Bacho Kiro), and assemblages from these sites were the primary axis for the evaluation and classification of Balkan MP industries. Even long after the height of the popularity of Bordes’ method of classification of industries and the establishment of Mousterian facies in southwest France, the method was still widely embraced across Europe, a trend that did not bypass these regions either. Assessments of the Balkan MP were made using indices as defined by Bordes (Ivanova, 1979; Ivanova and Sirakova, 1995), but also relying on a general evaluation of technological and typological features (Kozłowski, 1975), that served to make connections between sites and to build culture-historical units based on their similarities. Additionally, some early combination of indices and attribute analysis was undertaken (Sirakov 1983), and a
complete study of reduction sequences that significantly departed from the typological approach was also undertaken (Baumler, 1987). The final facies list that resulted from these initial studies overlapped between researchers, though with some variation in how sites were grouped. Needless to say, the different facies groups were conceived of as distinct culture-groups (Basler, 1975a; Kozłowski, 1975). Decades later these NASTIES

![](https://engineering.purdue.edu/Stratigraphy/tscreator/index/index.php)

**Fig. 2** Chronological overview of the Balkan Middle Paleolithic sites with radiometric ages (green), sites with chronological designation based on sedimentological, stratigraphic, microfaunal, or faunal estimates (black), sites where the chronological range is based on a continuous stratigraphic record, but without reliable chronology and human presence during particular time periods not demonstrated (gray). For radiometric dating see Supplementary Tables. Sites with only infinite ages are not included (e.g., Malisina, Smolucka). Figure is made with the help of TSC Creator software (https://engineering.purdue.edu/Stratigraphy/tscreator/index/index.php). Bentic curve by (Lisiecki and Raymo, 2005)

(“named stone tool industries”) (Shea, 2014) still remained in use (Basler, 1983; Ivanova and Sirakova, 1995; Mihailovic and Mihailovic, 2009), mainly because a new and more substantial record that might provide an impetus for taking a fresh look at industrial
variability is missing but also because reevaluations of the collections that constituted
the core of the facies definitions have not been systematically undertaken. Nevertheless,
recent research has to a certain extent clarified what some of these assemblages
represent technologically and typologically (Dogandžić and Đuričić, 2017; e.g.
Mihailović and Bogićević, 2016; Sitlivy, 2016).

Charentian and Typical Mousterian are two facies of Mousterian from the Bordes’
classification system that have been commonly applied to industries of the Balkan. The
Southeastern Charentian was recognized by Gabori, Ivanova, and Kozłowski, and refers
to three assemblages in the Croatian northwest: Krapina, Veternica, Vindija (Gabori,
1976; Ivanova, 1979; Kozłowski, 1975). Their features - high scraper index, low to zero
Levallois index, simple cores sometimes resembling Pontian cores (on pebbles),
discoidal cores, and scrapers with Quina and demi-Quina retouch particularly in
Krapina - approximate Quina Charentian in France but are somewhat distinct and
deserve their own separate group (Gabori, 1976; Kozłowski, 1975). Additionally, atypical
Charentian is separated at several sites in Bulgaria (Bacho Kiro 14, Samuilitza, Temnata
Dupka), with single convex and bifacial scrapers (Ivanova and Sirakova, 1995).
Depending on the values of technological and typological Levallois indices, Kozłowski
separated Levallois Mousterian (Bacho Kiro 12/13) and Moustero-Levalloisian (lower
Levallois indices than the former and high scraper index, Bacho Kiro 13, Crvena stijena
XIII-XVII); a division corresponding to a Typical Mousterian Levallois version (Bacho
Kiro 12/13, Samuilitza, Temnata) and a non-Levallois version (Bacho Kiro, 13) (Ivanova
and Sirakova, 1995). East Balkan Mousterian with bifacial points (Ivanova and Sirakova,
1995) or Moustero-Levallois with leaf points (Kozłowski, 1975) are recognized at the
Bulgarian sites of Mouselievo-Samuilitza, and also Kokkinopilos in Greece, and,
according to Kozłowski, is a Moustero-Levallois complemented by leaf-shaped points.

Under the name Balkan Mousterian, Kozłowski included assemblages with a
high scraper index, average technical Levallois index, and a high Charentian scraper
index. He merged assemblages, usually from lower levels at several sites like Crvena
stijena XXIV, Asprochaliko 18, Bacho Kiro 14, and Londza and Kamen, into this group.
The latter two sites from Bosnia and Herzegovina, Gabori (1976) termed Late
Mousterian with Levallois debitage (Gabori, 1976). Particularly based on the lower levels
at Crvena stijena, which feature various side-scrapers, double and convergent forms, bifacially and unifacially retouched, and many scrapers with ventral thinning, Kozlowski gave a “Charentoid” character to the Mousterian at Crvena stijena and subsequently to all Balkan Mousterian (Kozlowski, 1992). Ivanova (1979), however, designated these assemblages as Typical Mousterian but very rich in sidescrapers and points (and named it “Crvena stijena a – Pinios”). Some of these assemblages (e.g. Krapina, Zobište, Asprochaliko) have also been examined free from the constraints of Bordes’ method and, as much as the collections allowed, described in terms of blank production methods and the associated tool use (Baumler, 1987; Gowlett and Carter, 1997; Papaconstantinou, 1989; Simek and Smith, 1997); however, their typological classification still remained in use.

Of other facies hitherto defined elsewhere, Pontinian and Denticulate Mousterian have been proposed for Balkan industries as well, and both are primarily identified at Crvena stijena (Basler, 1975b). For the Pontian, the flaking of pebbles to obtain cortical blanks and an abundance of scrapers link this eastern Adriatic assemblage with its counterpart in central Italy, and these are seen as broadly related to Quina/Charentian industries (Taschini and Bietti, 1979). Similar to what is seen in western MP, Basler held that the Denticulate facies was a phenomenon that characterizes the late phases of the Mousterian (Basler, 1975b, 1983). This facies was potentially recognized at other sites, e.g. Temnata Dupka (Drobniewicz, Ginter and Kozlowski, 2011; Kozlowski, 2002).

However, not all assemblages and industries were subjected to a typological classification; for instance, Micromousterian has been defined as a facies consisting of assemblages whose size of artifacts are comparatively small (though the threshold was never defined). This group incorporates assemblages with a range of technological and typological characteristics and is predominantly related to the industries in the southern, Mediterranean belt (Asprochaliko, Crvena stijena, Klissoura, Bioče, etc.) (Dogandžić and Đuričić, 2017; Gowlett and Carter, 1997; Mihailović and Whallon, 2017; Papaconstantinou, 1989; Sitlivy et al., 2008). These assemblages have often been compared to the Pontinian in Italy, with reference to the small size of artifacts, and thus interpreted as a typical but diminutive version of Mousterian primarily due to raw
material constraints (Basler, 1975b, 1983; Rink et al., 2002). Others have suggested that the smaller nodules have been purposefully selected for the small flake production (Đuričić, 2006; Ђуричић, 1997). Another deliberate small flake production is suggested for Asprochaliko through a core-on-flake method similar to Kombewa (Papaconstantinou, 1989).

5.4 MAIN TENDENCIES IN CHRONOLOGICAL AND SPATIAL VARIATION OF THE MIDDLE PALEOLITHIC INDUSTRIES

5.4.1 THE LOWER PALEOLITHIC BACKGROUND

In contrast to western Europe, the ‘Levallois generalization’ (Richter, 2011) in SE Europe does not emerge in an Acheulean context. Isolated bifacial handaxes that could be attributed to the Lower Paleolithic have been discovered in southern Croatia (M. Malez, 1979), Albania (Harrold et al., 1999; Runnels et al., 2009), and the northern parts of Greece including the islands (Dakaris et al., 1964; Galanidou et al., 2012, 2016; Reisch, 1982; Runnels, 2003; C Runnels and van Andel, 1993; Tourloukis, 2010), and there are atypical bifacial elements in surface collections in the West Rhodopes (Bulgaria) (Ivanova, 2016) (Fig. 3). The bifacial component in the Kokkinopilos assemblage from Greece, one of the most notable Lower Paleolithic locations in the region, cannot be assigned with certainty to either late Lower or early MP without a proper sample and technological study, though its occurrence certainly predates the Last Interglacial based on luminescence dating of artifacts from two different overlying units yielding ages of 172 ± 25 ka and 206 ± 19 ka (Tourloukis et al., 2015). It seems, however, that the Lower Paleolithic technological “background” preceding the appearance of Levallois in Central and Eastern Europe and the Balkans was not predominantly bifacial and consisted rather of mainly a core-and-flake assemblages.

A non-Acheulean industry with the presence of preferential cores comparable with Levallois or discoidal technology is noted in Kozarnika cave (Bulgaria), Levels 13-11a, dated to >400 ka (Guadelli et al., 2005; Sirakov et al., 2010). Industries that generally feature choppers, cores for flakes, flake tools, cores on flakes, and lack Levallois and bifacial production are present at Dealul Guran (Dobrogea, Romania) (Iovita et al., 2012,
2013), Rodia, an open-air site in Thessaly (Greece) (CN Runnels and van Andel, 1993; Tourloukis, 2010), Gajtan cave (Albania) (Darlas, 1995), Yarimburgaz cave located on the Bosphorus (Turkey) (Arsebük and Özbaşaran, 1999; Kuhn et al., 1996), and most of these are tentatively placed around MIS 11, while the newly discovered site Marathousa (Greece) dates to MIS 16 or 14 (Panagopoulou et al., 2015, 2018).

Fig. 3 Map of major Lower Paleolithic sites in the Balkans predating the widespread use of Levallois (MIS 11 –MIS 9?). Green: core and flake assemblages; blue: sites with handaxes. Handaxes in surface context are also found in central Albania (Runnels et al., 2009), Paleokastron in Greece (Dakaris et al., 1964), and Croatia (Mirko Malez, 1979). Abbreviations of site names: DG – Dealul Guran, Gt – Gajtan, Kp – Kokkinopilos, Kz – Kozarnika, Rd – Rodia, Rf – Rodafnidia, WM – Western Morava sites, Yr – Yarimburgaz.

General assemblage features from these Middle Pleistocene sites display certain similarities with Middle Pleistocene assemblages from central or eastern Europe, such as Vértősszőlős (Kretzoi and Dobosi, 1990), Bilzingsleben (Haidle and Pawlik, 2010; Pasda et al., 2012), Korolevo I (Koulakovska et al., 2010), and many others (Burdukiewicz and Ronen, 2003; Doronichev, 2016; Rocca, 2016). The industries from this wide region between the Alps and the Caucasus share an absence of bifaces and Levallois production and are characterized by simple and informal production processes with cores with one
or multiple platforms, simple toolkits on small blanks and the presence of choppers (Doronichev, 2016; Doronichev and Golovanova, 2010). The differences that do exist most probably are the result of local factors such as raw material properties and site function.

It was suggested long ago that the similarities in these Balkan industries allow for the definition of a Pre-Mousterian industrial complex (Obermeier, 1925) that coincides with the Movius line (Movius, 1948) such that it is synchronous with the Acheulean but outside of the Acheulean’s geographical range. These industries chronologically fall at least in the period between 400-300 ka, but an earlier age, c. 700 ka, is likely and some industries may have persisted longer, until c. 200 ka (Doronichev, 2016). A gradual transition from the Acheulean to Levallois production is, therefore, an unlikely scenario in this region (Doronichev, 2016). Several sites, however, may contain technological elements of a proto-Levallois production system, such as the open air site in Velika Morava valley in Serbia (D Mihailović et al., 2014) and Kozarnika (Sirakov et al., 2010). These sites have a potential to shed light on the early appearance of Levallois technology.

New data from current research in the Western Morava valley (Serbia) has a potential to elucidate the beginning of the MP in the region (Heffter, 2014; D Mihailović et al., 2014; Mihailović and Bogićević, 2016). Over 30 locations with surface finds have been registered, with a few of them containing large amounts of material. Some locations have typical LP technology with many choppers and chopping tools, while assemblages from other locations contain proto-Levallois cores on pebbles, Kombewa cores, choppers and some Levallois products. Both elements of Lower and Middle Paleolithic technology have been encountered. These assemblages could date to roughly 400-300 ka, certainly before the Last Interglacial (D Mihailović et al., 2014; Mihailović et al., 2009), however, the chronostratigraphic context is not certain. The observation that the blank production incorporated elements of Levallois technology with the use of choppers and Kombewa technique signifies the great potential of these assemblages in understanding the technological aspects behind the Lower to Middle Paleolithic transition in SE Europe and the appearance of Levallois technology.
5.4.2 ARE THERE MIDDLE PALEOLITHIC TECHNOLOGIES BEFORE THE APPEARANCE OF LEVALLOIS?

Levallois technology is conventionally taken as the hallmark of the MP (Ronen, 1982; White and Ashton, 2003) and is roughly concurrent with the development of Neandertals as taxon (Hublin, 2009). Aside from regular use of Levallois, the dominance of other flaking systems that are characteristic of the MP, such as discoidal or Quina, may mark the beginnings of the MP (Richter, 2011).

The best evidence for early MP techno-typological elements predating the appearance of Levallois comes from Velika Balanica cave (Mihailović, 2009b, 2014a; Mihailović and Bogićević, 2016) (Fig. 4). Its relative stratigraphy suggests that previous to the earliest widespread use of Levallois technology (Level 2), MP industries were characterized by the production of asymmetrical, thick and cortical blanks, often with Clactonian platforms and high interior platform angles, which were transformed into numerous scrapers, many of which went through intense resharpening and exhibit a scalar retouch (Levels 3) prompting their classification as Charentian (Mihailović, 2014b; Mihailović and Bogićević, 2016) (Fig. 5 – 4-8). A regional analogy can only be made with the very small but homogeneous assemblage at Theopetra Level II1 of at least MIS 6 age (Panagopoulou, 1999, 2000; Valladas et al., 2007b) (See Supplementary Tables for all radiometric ages). It exhibits a similar trend of producing thick and cortical blanks that are often transformed into Quina-like scrapers, and it predates an assemblage with Levallois use (Fig. 5 – 1-3). Interregional comparisons take us to MIS 4 and MIS 3 in southwest France. Here the prevailing techno-typological behavior is marked by the distinct Quina technology with the associated typological signature of Quina scrapers. This particular techno-typological combination has been defined and researched intensively, along with the particular subsistence and mobility behavior related to reindeer hunting (Bourguignon, 1997; Delagnes and Rendu, 2011; Discamps et al., 2011; Faivre, 2008; Guibert et al., 2006; D. Richter et al., 2013; Turq, 1989, 2000). However, it is not restricted to the narrow timeframe of the late MP; at several sites in the same region (e.g. Les Tares, La Micoque 3) analogous techno-typological behaviors have been observed which date prior to MIS 6, most probably even earlier than 300 ka (Delpech et
al., 1995; Geneste et al., 1997a; Geneste and Plisson, 1996; Le Tensorer, 1978; Texier and Rigaud, 1981; Turq, 1992). It has been recently proposed that industries of this type from Velika Balanica are rather chronologically and spatially related to similar technotypological phenomena in the east (Mihailović, 2009b; Mihailović et al., 2009; Mihailović and Bogićević, 2016). In Anatolia, for instance, there was a similar shift from a predominant Quina-like technological behavior (named ‘Proto-Charentian’) to a prevalent Levallois use at Karain (Turkey). This shift is dated to at least MIS 6, or even earlier, placing the ‘Charentian’ to perhaps MIS 9 (Kozlowski, 2002; Otte et al., 1999; Rink et al., 1994). Again, further to the east, within Achelo-Yabrudian or Mugharan industries, dated to MIS 9 (Mercier, 2003; Rink et al., 2004), aside from bifacial shaping and blade production, characteristic is a non-Levallois production of thick and broad blanks that are often used for scrapers with a distinct scaled Quina-like retouch (Al Qadi, 2011; Gopher et al., 2010; Lorraine, 2000; Shimelmitz et al., 2014). Regardless of the causes of the observed coherence of this combination of technological and typological elements typical of the MP, across the wide region (e.g. population movements or contacts, functional factors), it is important to stress this early appearance of MP technological components - other than Levallois - in industries in the Balkan region (a phenomenon of “Mousterianization” as defined by (Delagnes, 1992)).

5.4.3 WIDESPREAD USE OF THE LEVALLOIS METHOD IN MIS 6 AND MIS 5

Unambiguous appearance of Levallois technology is related to MIS 6 or even MIS 7 (Crvena stijena, Kozarnika, Velika Balanica, Temnata Dupka) (Fig. 4A), when this, and other centripetal methods to a lesser extent, come into a rather frequent use. Particularly at Velika Balanica and Theopetra, the emergence of Levallois is fairly abrupt, as it arrives after MP industries with no indications of Levallois production. Typologically, these assemblages still consist of high scraper frequencies, but this time with lateral and double forms (e.g., Crvena stijena, Velika Balanica) rather than transversal ones, while tools with a modest amount of edge modification prevail at others (Kozarnika, Temnata Dupka).
Fig. 4 Map of sites in different MIS stages. A – Pre-Emian sites. Most probably dated to a period between MIS 9 and MIS 6. Red: Levallois based assemblages, Blue: non-Levallois assemblages. B – Sites from the MIS 5. Blue: MIS 5e, orange: MIS 5 d-a. C – Sites from MIS 4; Red-white circles – occupations imprecisely associated with MIS 4, red circles - radiometric age associated with MIS 4 (Supplementary Table 1). D – MIS 3. See Table 1 for site abbreviations.

Levallois method remains a regular blank production method throughout the MIS 5 (Fig. 4B) and it is prominently characterized by the production of larger, elongated blanks through uni- and bidirectional removals. This is evident at MIS 5e occupations at Theopetra IIa-8 (Panagopoulou, 1999, 2000), the most likely MIS 5a Level XXIV at Crvena stijena (and potentially earlier Levels, XXVII-XXIV) (Kozlowski, 1992; Mihailović, 2009c, 2014b, 2017; Mihailović et al., 2017), and MIS 5a-d levels at Asprochaliko 18 (Gowlett and Carter, 1997), and Zobište (Baumler, 1987, 1988) (Fig. 6). The production of elongated blanks often proceeded with a radial detachment resulting in regular flakes and with radial/discoidal remnant cores (e.g. Zobište, Asprochaliko). While no particular method for the production of elongated elements could be inferred due to the scarcity of cores and technical elements, a significant amount of elongated
blanks and blades are common in Crvena stijena XX, XVIII (Dogandžić and Đuričić, 2017; Mihailović, 2014b; Mihailović and Whallon, 2017). These levels are associated with MIS 5d-a based on geology but new radiometric dates place them post-MIS 5, likely MIS 4 (Mercier et al., 2017). Elongated Levallois blanks are present in MIS 5 Level 5 in Hadži Prodanova cave (Mihailović, 2008; Mihailović and Mihailović, 2006). The lower levels at Klissoura (XX-XV), most likely belonging to MIS 5 (Starkovich, 2014, 2017), contain a significant amount of blades produced through a volumetric-like method, not Levallois, even though Levallois is often used here (Sitlivy et al., 2007, 2008). In addition to the use of Levallois to produce elongated blanks, notable is the presence of blade production at Theopetra II4-8, attested to by bidirectional blades, crested and overshot blades, and core tablets. This similarity to UP-like volumetric core exploitation led the authors to associate this to a transitional type of industry (Panagopoulou, 1999, 2000).
which was subsequently invalidated by TL dates (Karkanas et al., 2015; Valladas et al., 2007a). There is a possibility that these artifacts come from the UP level above (that, however, are not rich in finds and show no straightforward blade production), but until this is resolved, one may entertain the idea that the existence of blade production in the interglacial context is rather genuine, especially having in mind the occurrence of blade production in the MP elsewhere in Europe during the Eemian and pre-Eemian (Bar-Yosef and Kuhn, 1999; Delagnes, 2000; Koehler, 2011; Locht et al., 2015; Révillion and Tuffreau, 1994; Tuffreau, 1995). At Temnata Dupka, more Levallois relative to other layers is noticed in early glacial levels, and evidence of volumetric blade production is observed as well (Drobniewicz, Ginter, Kozłowski, et al., 2011). While no finer analysis of the Lakonis’ sequence and material from MIS 5 – MIS 3 that can address temporal trends is available, its industry with notable Levallois production of elongated blanks and a volumetric blade production is considered to bear similarities with other MIS 5 assemblages (Papagianni, 2009).

5.4.4 Not only Levallois – technological variation in the early Middle Paleolithic

Several assemblages of MIS 5 age with low to moderate presence of Levallois blank production bear evidence of a production of naturally backed, thick blanks, selected for the manufacture of scrapers. As a reminiscence of earlier industries previously discussed (MIS 9 -?7?), this blank production method is evident in MIS 5e at Krapina, especially in the upper part of the sequence, with the frequent use of the core-wedge method, similar to bipolar (Simek, 1991; Simek and Smith, 1997). For this reason, assemblages from Krapina and near-by Vindija and Veternica were grouped into the Charentian-Quina type (Ivanova, 1979). Blanks of this morphology are commonly transformed into scrapers in Pešturina’s MIS 5 Level 4 (Mihailović and Milošević, 2012), and in the Crvena stijena Levels XXII, XX, XVIII (MIS 5 or MIS 4) (Fig. 7 1-3) where they have been named Pontinian (Dogandžić and Đuričić, 2017; Mihailović, 2014b). If the latter levels can be securely attributed to MIS4, the presence of these techno-typological features would coincide with similar phenomenon during the same time period in SW France (Mihailović, 2017).
Fig. 6 Selected artifacts from Asprochaliko Basal level (1-5) redrawn after Gowlet and Carter 1997 and Theopetra phase 2 (6-8) redrawn after Panagopoulou 2000
When Levallois occurs with the production of naturally backed blanks in the same assemblage, it is worth examining whether these result from separate reduction trajectories. At the MIS 5d-a industries at Zobište the production of naturally backed elements, that were selected for scrapers, was part of one continuous process that starts with Levallois-like unidirectional exploitation and ends with radial detachments of flakes (Baumler, 1987). At other sites small assemblages do not allow for such examination; however, some diachronic patterns can be observed. At Crvena stijena,
notable is the shift from the predominant use of Levallois in XXIV (likely MIS 5a) to the habitual production of naturally backed blanks in subsequent Levels XXII-XVIII. In Krapina’s typologically homogeneous assemblage dominated by sidescrapers, a diachronic pattern during the short time span of MIS 5e is seen where patterns of blank production varied from a high frequency of Levallois blanks to the wider use of cortical backed blanks. If one bears in mind the curation and stratigraphic difficulties of this assemblage it may be difficult to discern whether these are two different flaking trajectories (Simek and Smith, 1997) or part of the same sequence that parallels Zobište as suggested by some (Baumler, 1988). Within 10 stratigraphic units, not chronologically distinguishable, two peaks in lithic densities led to the hypothesis there were at least two occupations of this site (Simek and Smith, 1997).

In sum, MIS 5 industries show the use of two main blank production methods, Levallois on one side, at times accompanied by volumetric-like blade production methods, and on the other side a tendency to produce thick cortical blanks. Both technological contexts share a common emphasis on the production of scrapers often increasingly resharpened. In a broad sense, this technological diversification in a typologically similar context broadly corresponds to the Ferrassie vs. Quina Charentian dichotomy in SW France (Geneste et al., 1997b). Thus far, at sites in the Balkans, flaking methods for producing thick cortical flakes are not well understood and it is not entirely clear whether the method truly corresponds to Quina as described elsewhere (Bourguignon, 1997); moreover, assemblages rather show fluctuating importance of producing one blank morphology over another - large and thin Levallois blanks vs. thick and cortical blank.

5.4.5 Scraper rich assemblages common in the Early Middle Palaeolithic

While typologically all assemblages during this time period are rich in scrapers, they differ in tool production intensity and in the intensity of tool modification. In some assemblages tools comprise a smaller percentage and/or do not exhibit particularly extensive resharpening (e.g. Zobište, Asprochaliko, Temnata Dupka), while others have a higher frequency of tool production, more elaborate production of scrapers, and heavier edge modifications (Crvena stijena, Theopetra, probably Krapina). Between
assemblages with predominant Levallois use, there is a difference in the frequency of retouched tools and the intensity of retouch that may stem from more economical concerns, namely different degrees of reduction that in turn may fluctuate according to functional aspects of site or settlement patterns. For instance, assemblages that share the production of often elongated blanks through the Levallois method - Asprochaliko, Zobiște, and Theopetra – have different patterns of tool use intensity. The rich assemblages of Asprochaliko and Zobiște have fewer tools and less edge resharpening on scrapers, while Theopetra’s smaller assemblage has less stone tool production intensity, in terms of blank production, but is abundant in tools, many of which exhibit heavier edge modification. This said, a perspective that takes into account use life of a tool may explain the variation between assemblages that predominantly use the Levallois flaking method, analogous to the variation in other MP contexts; namely in SW France where the difference between the Ferrassie and Typical Mousterian facies is understandable as a consequence of economic factors that would more or less stress frequent tool use and reuse (Dibble, 1995; Faivre et al., 2014).

Earlier studies of the Balkan MP emphasized the particular typological signature of Crvena stijena levels attributed to MIS 6 and MIS 5 (XXVIII-XXIV). It featured the use of Levallois, various side-scrapers, among them double and convergent forms, bifacially and unifacially retouched, frequent ventral thinning on scrapers and the analogous truncated-faceted pieces (potentially evidencing small flake production). These features are shared with the contemporaneous Theopetra and Karain assemblages, and further to the east related to similar techno-typological phenomena in the Zagros Mousterian (Kozlowski, 1992; Kozłowski, 1975, 2002; Panagopoulou, 1999). Its western counterpart would be Ferrassie Mousterian (Dibble, 1991; Geneste et al., 1997b). This similarity across extensive territory supported an idea of a unified culture among Neandertals in Europe and further to the east, potentially suggesting migrations (Kozlowski, 1992; Kozłowski, 2002). A further reinforcement of this idea came from a paleoantropological perspective that supported the eastward ‘expansion’ of Neandertals during MIS 6/5 (Hublin, 2002; Kozlowski, 1992; Kozłowski, 2002).

In sum, MIS 5 assemblages show greater technological variability with various blank production methods being used simultaneously at times. Flaking methods
introduced during the pre-Eemian MP (at first production of thick blanks as in Velika Balanica and later the Levallois method) appeared as distinct techno-economic concepts that were practiced independently. Once they became incorporated into the MP repertoire, these concepts were integrated into the MP technological package (Kuhn, 2013; Pettitt, 2003). These blank production methods appear to be concomitantly used at any one time (period/occupation?) at some sites, for instance at Crvena stijena XVIII or Krapina (potentially Petrovaradin as well, pending future age estimations (Mihailović, 2009a)). Whether there is any regional differentiation in the distribution of these patterns is impossible to say for the moment, given the low number of sites from this time period; however, in the eastern Balkans (Bulgaria), thus far only the Levallois component is present, with some early presence of bifacial flaking (see below).

Earlier descriptions and interpretations of the Balkan MP (Ivanova, 1979; Kozłowski, 1975) labeled these industries according to technology (Levallois Mousterian) or sometimes typology (Charentian), and at times the same assemblage would be placed in the two different facies (for instance, Crvena stijena XXIV). We would like to stress the tendency for scraper production in most of these assemblages. The principal difference, however, is in the blank morphology and technological process used to obtain blanks for scraper production, namely Levallois with a tendency to produce elongated blanks, rarely accompanied by blade production, and a less elaborate way of producing thicker and often cortical blanks. Both blank morphologies (wide and thin blanks and relatively thicker blanks) have a potential for further edge exploitation (Kuhn, 1992; Lin et al., 2013; Meignen et al., 2009; Pettitt, 1992; Turq, 1989) but differ in which aspect of blank shape, area or thickness, is used for extending edge use. This said, the major theme of these earlier assemblages, one may suggest, is an emphasis on the resharpening potential of a blank, where patterns of techno-typological production is directed towards tool use and extending tool use life. Depending on the prevalent flaking method, Levallois blanks/blades and/or naturally backed knives were selected for retouch. Notwithstanding the obvious functional background of these technological solutions, one may wonder if other factors would affect selection of one option over another, especially if both offer blanks with long-term use potential. Whether these differences indicate distinct cultural groups and can be explained from a culture-
historical perspective (Boëda et al., 1990; Delagnes and Meignen, 2006; Geneste et al., 1997b) or whether, as some have suggested, these differences reflect responses to changing environmental circumstances and the concomitant changes in mobility or hunting practices remains to be determined.

5.4.6 LATE MIDDLE PALEOLITHIC VARIABILITY AND REGIONAL DIFFERENCES

Variability in flaking methods

As the presence of Neandertals in the region during the MIS 4 is not well presented, our knowledge of the late variability of their industries relies on MIS 3 assemblages and stratified sites where the features of the late MP are discerned when viewed relatively to earlier deposits. The overall technological theme in this period is use of centripetal methods of flaking but with less frequent and less standardized Levallois production and instead more often discoidal and less formal radial flaking methods. However, whether there is any directionality, at a chronological scale, in regional variation or in how flaking practices relate to toolkit organization, may be more demanding to grasp.

The southern coastal zone offers numerous sites, many of them stratified, for temporal changes to be examined. The facies frequently assigned to the majority of MP industries from these sites (particularly in the late MP) is the Micromousterian (Asprochaliko, Crvena stijena, Mujina cave, Bioče, Klissoura) (Fig. 7). The small size of the artifacts has been recognized as a particularity of industries at Crvena stijena (Benac and Brodar, 1958; Brodar, 1962) and in Asprochaliko’s upper level (Higgs and Vita-Finzi, 1966). Later, when assemblages with artifacts of smaller sizes in sites along the Mediterranean coast of the Balkans (Greece, Montenegro, Croatia) are discovered and described, analogies were made with the former two sites based on artifact size alone. Consequently, the Micromousterian designation remained restricted to the southern region. However, some assemblages outside of the southern Balkans are also composed of artifacts of comparably small sizes (e.g. Petrovaradin with average size of 25 mm (Mihailović, 2009a), Velika Pecina (Karavanić, 2007), even Temnata Dupka (Drobniewicz, Ginter, Kozłowski, et al., 2011) shows a small, ~3 cm average blank size)
but have rarely been allocated to the Micromousterian and related to the Mediterranean MP. The small size of flakes in an assemblage may stem from several different and not mutually exclusive factors such as raw material size, flaking reduction intensity, prominent and intentional small flake production, and so a more detailed examination of these factors is required prior to (or instead of) simply putting them together in a single Micromousterian unit. For instance, at many sites in the Mediterranean region where the Micromousterian designation has been frequently used, one factor that is constant is the small locally available raw material that largely configures the lithic assemblage and appears as a major explanatory factor of the small artifact size. However, within this context, intersite differences in artifact size and assemblage structure, as observed at Crvena stijena and Bioče, are due to raw material conditions, namely the distance and the source type (primary versus secondary) and to reduction intensity as well (Dogandžić and Đuričić, 2017). Moreover, at stratified sites, if one assumes that raw materials remain roughly constant, there is still a certain degree of variation in flaking methods, tool production and use that are more relevant for understanding the variability of MP industries than the artifact size alone. This said, there is a necessity to look for techno-typological patterns beyond the artifact size as a common denominator for these industries. For instance, at sites that show an evidence of raw material constraints, primary driving factors of techno-typological variability are shifts in the predominance of flaking methods (Dogandžić and Đuričić, 2017; Gowlett and Carter, 1997; Mihailović and Whallon, 2017; Papaconstantinou and Vassilopoulou, 1997; Papagianni, 2009; Sitlivy et al., 2008). Changing flaking methods are furthermore partially responsible for the microlithic appearance of some industries (Asprochaliko) (Papaconstantinou, 1989).

At these sites, and particularly at sites that afford assessments of temporal tendencies, a rather general trend is observed. In earlier phases (MIS 5), blank production is more frequently organized towards the production of blanks that are suitable for scrapers, usually large and long Levallois blanks, and/or thicker blanks convenient for resharpening. In contrast, subsequent phases of the MP feature centripetal flaking with rather low incidence of Levallois production (Papagianni, 2009). The reduction pattern where Levallois flaking produced less standardized radial forms
and remnant discoidal cores in the later stages of reduction is apparent in earlier periods (MIS 5, e.g. Zobište, Asprochaliko), but what differentiates later, MIS 3 assemblages in general, is their less pronounced Levallois character, less of a tendency towards the production of larger implements, and an overall production that is not aimed at large blank manufacture for transformation into scrapers. This broad two-partite division of MP industries, where non-laminar and non-Levallois assemblages are present in the upper/later stages, has been proposed for Greek assemblages firstly, following the sequence at Asprochaliko, and later at other southern sites (Papagianni, 2009; Runnels, 1995). At some stratified sites changes are likewise marked by the diminution of flaking methods directed towards the production of thick blanks for scraper production (e.g. Crvena stijena) (Dogandžić and Đuričić, 2017; Mihailović, 2017; Mihailović and Whallon, 2017) and the decline of elongated Levallois products for scraper production (e.g. Asprochaliko) (Papaconstantinou, 1989; Papaconstantinou and Vassilopoulou, 1997). Instead, a production pattern with less formal centripetal flaking, exploitation of cores until their exhaustion, and alternative flake production methods, e.g. secondary blank production via cores on flakes, are rather common. Crvena stijena’s late MP deposits (Levels XIV-XII) feature industries with an increasing use of discoidal and radial flaking and fewer Levallois products. Most cores are small and reduced, there are cores on flakes, and the particularity is the presence of cores that resulted in the production of small often elongated products (Dogandžić and Đuričić, 2017; Mihailović and Whallon, 2017) (Fig. 7 – 4-7).

In the upper Mousterian at Asprochaliko, the so-called ‘Asprochaliko flaking method’ (Papaconstantinou, 1989) is similar to discoidal (Bailey et al., 1992; Boëda, 1997) as it produces short and thick blanks, though through a ramified production where blanks are used as cores. This production of small pointed pseudo-Levallois points, from Kombewa-like cores or from the truncated-facettened method, is considered an indicator of the purposeful production of small blanks (Papaconstantinou, 1989; Papaconstantinou and Vassilopoulou, 1997). In any case, pseudo-Levallois are very common and almost 30% of all retouched blanks are of this morphology (Fig. 7 – 8-11). This is in contrast to somewhat more elongated Levallois element production in the earlier (MIS 5) phases at this site, suggesting a more distinct diachronic change in blank
production (Papagianni, 2000, 2009). The small MIS 3 assemblage at Mujina cave contains very few pieces diagnostic of any particular technology of blank production, though the site is interpreted as a workshop which probably reduces the technological variability (Karavančić et al., 2008). Informal cores for small flake production are present as well. Broadly, at Kalamakia, the main temporal shift in flaking method is the decreasing use of Levallois in upper levels (Darlas, 2007a).

These data on temporal variation suggest a change to less ‘standardized’ production methods, at least compared to Levallois production of large blanks/blades, and indicates situational and less formal blank production through centripetal and often discoidal methods. How data from stratified sites at Klissoura and Bioče compare to this is not entirely clear. At Klissoura, the middle and upper parts of the sequence (most likely MIS 3) have evidence of centripetal and discoidal flaking compared to earlier assemblages with notable blade production. Levels at the top of the MP sequence feature many blade and bladelet cores. These are similar to the upper levels at Crvena stijena. At Bioče, levels of the upper sequence (MIS 3?) are overall characterized by centripetal flaking methods. The predominance of discoidal flaking methods in the latest phases is replaced by a slightly higher presence of Levallois products, with the occurrence of blade and elongated products, and flake production through truncated-facetted pieces (Dogandžić and Đuričić, 2017). The chronology of these levels, however, is not yet determined.

The temporal patterns in lithic variation described here are principally based on stratified sites in the southern Mediterranean (Dogandžić and Đuričić, 2017; Mihailović and Whallon, 2017; Papagianni, 2009; Sitlivy et al., 2008). This brings us to the question of whether a parallel trajectory is observed in other regions within the Balkans or whether industrial variations are inherent to geographical regions. It may not be completely unexpected that different regions see contrasting developments given that in the Balkans the mountainous regions running across the peninsula may have posed barriers to population movements and therefore have structured variation and development of lithic industries, particularly in a north-south direction. Besides population movements, we can suppose that these different environmental conditions may have triggered different technological responses. Central and norther Balkans,
however, do not provide many stratified sequences or reliably dated MIS 3 sites for valuable comparisons for temporal trends. Data from some sites (e.g. Šalitrena) are still not published in sufficient detail to discuss here. Some parallels can be observed; for instance, at Pešturina, the late MP does not exhibit a sharp change in technology but contains many denticulates unlike MIS 5 deposits. Additionally, at some other stratified sites in the northern regions potentially the same trend is observed; for instance, at Vindija (Croatia), a site that topographically and environmentally belongs to the same zone as the northern Balkans, the most striking temporal trend is the use of Levallois flaking methods in the lower level k that U-\(\text{Th}\) dating places in MIS 5e, but Levallois flaking is almost absent in the upper, MIS 3 assemblages, that, furthermore, contain many denticulate and notched tools (Blaser, 2002; Karavanić, 2007; Karavanić and Smith, 1998). This pattern is rather similar to the one observed in the south and therefore suggests that this pattern may not be regionally specific. At Temnata Dupka, levels III (MIS 4?) II (MIS 3) show abundant discoidal products, simple flake production, cores on flakes, small residual cores (globular), many retouched flakes, and a relative increase in denticulate tools, but also contain volumetric and Levallois blade production.

**Geographical variation**

Other stratified sites in the east part of the peninsula (Bulgaria), however, show a slightly different picture. Bacho Kiro and Kozarnika have rather homogeneous industries with varied use of Levallois and discoidal methods and no sharp technotypological changes, except maybe at Temnata Dupka. Eastern regions, nonetheless, are relevant for another prominent phenomena of regional variation in lithic industries in the Balkans, and that is the occurrence of bifacial elements. The co-called ‘East Balkan Mousterian with bifacial leafpoints’ has been defined as a regional group covering only areas east of the Carpathian mountains, due to its overrepresentation in Bulgarian sites. It is also known as the Mouselievo-Samuilitza complex (Ivanova, 1979; Ivanova and Sirakova, 1995; Sirakova and Ivanova, 1988). Several sites in the Balkans’ northern areas have single examples of bifacial implements - Šalitrena terrace (B Mihailović et al., 2014), Risovača cave in Serbia (Gavela, 1988), Vindija in Croatia (Karavanić and Smith, 1998; Zilhão, 2009), and several specimens of leaf-points in Kamen (Bosnia), though these
latter are somewhat less typical and rather resemble bifacial scrapers (Basler, 1963, 1979; Ivanova, 1979). Petrovaradin likewise has scrapers with bifacial retouch (Mihailović, 2009a). This phenomenon is generally associated with MIS 3 and the late Mousterian. Several sites, however, have some evidence of bifacial production in the form of roughout pieces and somewhat less typical bifacial points even earlier than MIS 3, potentially MIS 5 (Temnata Dupka, Kozarnika), which suggests a longer duration of the use of bifacially flaked pieces (Drobniewicz, Ginter, Kozłowski, et al., 2011; Guadelli et al., 2005). Notwithstanding regional variation within bifacial production in central and northwestern Europe (Bosinski, 1967; Jöris, 2004; Richter, 2000; Ruebens, 2013; Soressi, 2002), it appears that there is a broader geographic delineation of bifacial production in Europe traced along topographic features. Namely, mountain regions of the Balkans, the Apennines, and the Pyrenees demarcate Europe’s MP bifacial production, leaving most of the central Balkans outside of this area. There are, however, exceptions; a high altitude open-air site in the Rhodopes, Shiroka Polyana has numerous leaf-shaped points (Ivanova, 1994; Ivanova and Sirakova, 1995), and surface assemblages in Peneios river in Thessaly (Runnels, 1988) and a couple in Albania (Runnels et al., 2009) with dozens of Szeletian-like foliates.

This said, an additional aspect to the regional differentiation of the production of bifacially flaked implements is whether their use and production is a characteristic of a particular site type, namely open-air versus in cave sites, where bifaces appear in smaller numbers. Even at the eponymous site of Samuilizta, the number of foliates is small \(n = 10\) compared to hundreds of leaf-shaped elements at the open-air site of Mouselievo (Kozłowski, 2003). What remains to be further explored is the question of how bifacial industries, with a likely long history in the eastern Balkans (e.g. Kozarnika), are related to similar phenomena in other parts of Europe (e.g. Micoquian) and particularly their relationship with transitional industries like the Szeletian or the Lincombian-Ranisian-Jerzmanowician.

Notable at several sites is the production of blades and bladelets in the latest phases of the MP. Blade production in Temnata Dupka, Samuilitza in the late MP phases, take the form of a volumetric production and Temnata additionally includes Levallois bidirectional method. These can potentially be examined in the context of transitional
industries and their potential role in the Initial Upper Paleolithic (Kozłowski, 2004; Tsanova, 2012). It is still an open question whether these industries were produced by Neandertals independently or represent an outcome of the interaction of the local population with the newcomers that were entering the continent; particularly since the Initial Upper Paleolithic at Bacho Kiro is associated with Homo sapiens (Hublin et al., 2020).

Increased elongated blank and blade production is noticed in the south, in Bioče and Klissoura, and at Klissoura and Crvena stijena there are cores for producing small elongated blanks (bladelet) (Dogandžić and Đuričić, 2017; Mihailović, 2017; Mihailović and Whallon, 2017; Sitlivy et al., 2008). This occurrence should be examined in the context of the transitional Uluzzian industry, which is best known from southern Italy but is also present in northern Italy (Famane) and in Greece at the site of Klissoura. Once more, there is a question of whether this technological behavior is part of the MP technological repertoire, and there is an increasing evidence that it was (Mihailović, 2017; Mihailović et al., 2017; Mihailović and Whallon, 2017; Peresani, 2011; Peresani et al., 2016). It is difficult to envision the influence of the modern humans in the production of these elements given that modern humans were not present in the southern Balkan region until late (see 5.2.3).

**Expediency as a Typological Signature in the Late Middle Paleolithic**

The principal typological theme in the late MP is the decreasing frequency of scraper types, sometimes associated with less tool production in general. Since scrapers on one side and notches and denticulate on the other size represent the two major categories in the MP tool repertoire (Dibble, 1988), increases in one will necessarily result in a decrease in the other group. In contrast to earlier stages that witnessed a trend in high scraper production, that were at times more regularly resharpened, many assemblages of more recent phases feature less emphasis on frequent and repetitive tool edge resharpening (Crvena stijena, Klissoura, Asprochaliko, Mujina cave, Pešturina, Samuilitza). The concomitant increase in the number of denticulates, notches, and simple retouched tools in the uppermost levels is noticed in many sites (Crvena stijena, Mujina cave, Temnata Dupka, Pešturina, Klissoura). For assemblages in the Adriatic
region this typological character prompted the proposition of a Denticulate facies, represented in caves (Crvena stijena, Mujina cave) and open-air sites in Dalmatia (Basler, 1975b, 1983; Batović, 1988; Karavanić et al., 2008; Rink et al., 2002). It remained to be discerned how dominant these tool types are compared to known Denticulate Mousterian facies that seem to be more restricted in time and space (Theodoropoulou, 2008; Thiébaut, 2010; Thiébaut, 2005). Are they similarly confined in geographical distribution and chronological framework? As for the latter matter, it appeared, however, that the incidence of denticulate tools is not restricted to the Mediterranean region (they appear in greater numbers in Temnata Dupka, Pešturina, Vindija) and one cannot speak of a regionally constricted phenomena as previously thought. Regarding the temporal confinement, with a potential exception of Temnata Dupka (MIS 4?) (Kozłowski, 2002), an increase in denticulate tools is a phenomenon related to later stages of the MP.

An increase in denticulate tool types, however, is often coupled with an increased occurrence of damaged pieces, thus suggesting that denticulated edges are likely the result of post-depositional processes that produced unintentional edge modifications (Kolobova et al., 2012; Thiébaut, 2010; Thiébaut, 2005). An increase in edge damage and pseudo-tools are expected in gravelly sediments, in anthropic sediments with contact between artifacts or as a result of trampling (Flenniken and Haggerty, 1979; McBrearty et al., 1998; McPherron et al., 2014; Nielsen, 2011) with the gravel size being one of the major factors affecting the frequencies of edge damage (McPherron et al., 2014).

At Crvena stijena and Bioče higher proportion of damaged pieces is observed in levels with higher incidence of denticulate tools (Dogandžić and Đuričić, 2017). Although an increase in denticulate tools in Mujina cave is associated with relatively less gravelly sediments (thus less taphonomic damage expected), some denticulate pieces resemble microdenticulation (Fig. 7 - 12-14) that is usually common on damaged edges. Open-air sites on the coast of Dalmatia are as well to be questioned as their deposition is not clear and potential reworking that could cause damage is not testable. Moreover, it has been suggested that the dominant type of these open-air assemblages are scrapers (Vujević, 2011; Vujević et al., 2017). One should not, however, forget that this pattern may result from the biased selection at open-air sites. Likewise, at Pešturina,
the edges of denticulated tools appear to be attributable to taphonomic processes (Mihailović and Milošević, 2012). This said, there is a great possibility that taphonomic factors play a role in the frequencies of denticulate pieces in all these assemblages. Before interpreting their significance in terms of industrial variability, edge damage should be examined to account for any taphonomical processes for each assemblage.

Still, denticulate tools are common in contexts of larger reliance on more expedient tool production and use (though there are cases of opposite (Picin et al., 2011)). In Level XII of Crvena stijena and Level 2 of Bioče the percentage of denticulates is high, though scrapers remain more frequent and therefore these assemblages are not defined as a Denticulate Mousterian. At Crvena stijena more denticulate tool production in the most recent Middle Paleolithic level XII is associated with less retouch and less resharpening and with more frequent lightly retouched flakes. Likewise, Level XII and particularly XIV, have a number of finely retouched thin flakes (raclette) along with cores that testify to small flake production. On the contrary, numerous denticulates co-occur with high frequency of scrapers and heavier retouch in Bioče upper levels (Dogandžić and Đuričić, 2017). In the latest, uppermost levels at Klissoura, the low production of tools is linked with fewer scrapers and an increase in denticulate tools, though still in very low amounts (Sitlivy et al. 2008). Mujina cave, where edge modifications are difficult to interpret as either resulting from taphonomic damage or use and light retouch, has very few retouched tools in general. As for the neighboring regions, a trend where scrapers are ‘replaced’ by denticulates is noted in Vindija (Janković et al., 2006; Karavanić and Smith, 1998), Riparo Mochi (Grimaldi and Santaniello, 2014; Stiner and Kuhn, 1992), and to some extent in sites in coastal Latium (Mussi, 2001).

When this typological signature is integrated with the previously described technological tendency in the later MP phases, a techno-economic model emerges (Dogandžić and Đuričić, 2017). Stone tool production in most cases did not target scraper production and resharpening as a major techno-economic strategy (unlike the earlier phases). A similar trend is observed in sequences in southwest France where during earlier phases lithic production is oriented towards scrapers production and use (Mellars, 1965; Monnier and Missal, 2014), and we see that a similar trend potentially
exists across the Balkans, at least in its southern regions. However, with a spatially and temporally patchy record, we are not entirely confident that the industries in regions beyond the Mediterranean zones (particularly in the east) follow the same pattern. For instance, at Temnata Dupka, throughout the sequence, tools are rare and the majority of the toolkit is comprised of retouched flakes, with scrapers and denticulate often amounting to the similar proportions, and at Bacho Kiro scrapers are the main tool type, whose proportions decrease in the latest phases. The previous importance of scraper production is the recognizable quality of earlier periods that is rarely seen in the later MP developments.

In sum, late MP in the Balkans features flaking methods that are already practiced throughout the earlier MP periods, centripetal flaking, exploitation of flakes as cores, and in some instances in the later phases, the production of blades through Levallois or volumetric methods. The major theme is the general and varied use of centripetal flaking methods with fluctuating, though usually low, presence of Levallois that is rarely if ever directed towards large flake production. The increased reduction intensity of cores which will then proportionally reduces the amount of Levallois blanks at the expense of radial and core edge flakes, especially when the reduction continues to a radial/discoidal manner, is one of the major factors that may affect this pattern; however, reduction intensity as usually measured does not always increase in these instances (Dogandžić and Đuričić, 2017; Papagianni, 2000, 2009). On the other hand, the flaking technology trend in the late MP is accompanied by the lesser importance on retouched elements and the renewal of their working edges.

Many late MP stratified sites in other regions testify to the frequent use of Levallois and discoidal methods of production though in changing proportions (Faivre et al., 2014; Meignen et al., 2009; Peresani, 2012; Picin et al., 2014). The order of the predominance of blank production methods has become an important factor in recent debates on the existence of chronological trends of Mousterian industries and their relationship with climate and subsistence (Discamps et al., 2011; Peresani, 2012; Picin and Carbonell, 2016; Stiner and Kuhn, 1992). It is worth examining the reasons behind changes in the relative importance of various debitage systems. If population crashes can be envisioned during the MIS 4, material culture is expected to respond to these
demographic changes with the lack of innovation and the loss of technological traditions in low population densities (Boyd and Richerson, 1985; Premo and Hublin, 2009; Premo and Kuhn, 2010; Richter, 2000). Likewise, climatic deterioration may have induced changes in subsistence and mobility strategies that would require changing techno-economic strategies. While certain trends do appear (e.g. low Levallois components in many later MP), directionality in technological behaviour in Balkan assemblages might be more difficult to demonstrate, as variation in stone tool production is rather low (this is particularly challenging when chronological information is lacking). Changes in strategies rarely involve the exclusive use of one flaking method over another. If this were the case, one might link these patterns to cultural groups delimited in time and space (e.g., Jaubert et al., 2011). This is less likely to explain the record. The shift seen in the late MP might be associated with situational, techno-economic behavior that would favor increasing the number of blanks and new edges rather than tool portability as expressed in repeated edge modification (Delagnes and Meignen, 2006; Delagnes and Rendu, 2011).

5.5 BIOGEOGRAPHY OF THE MIDDLE AND EARLY UPPER PALEOLITHIC HOMININS IN THE BALKANS

Parts of Pleistocene Europe underwent frequent episodes of human depopulation and recolonization resulting in only a partial occupation of certain areas (Dalén et al., 2012; Dennell et al., 2011; Hublin and Roebroeks, 2009; Roebroeks et al., 2011). The position of the Balkans for understanding this population history is somewhat contradictory; its refugial character and the presence of migration corridors would suggest a continuous and rich record of human occupation and yet the available record implies an almost sporadic human presence. This situation calls for an evaluation of the causes of the apparent sparse record, in particular whether it simply reflects a research bias or whether indeed it is a true pattern and, if so, what can account for this. We will make an attempt, based on the evidence at hand which is admittedly rather patchy, to illustrate the occupational history of the Balkans during the Middle and early Upper Paleolithic, both chronologically and spatially. Occupations in the early Upper Paleolithic are relevant for contextualizing the Neandertal demise and population
replacement.

Genetic studies on past human demography primarily center around the question of effective (breeding) population size, that varies widely (Briggs et al., 2009; Fabre et al., 2009) and does not relate to census population size in a straightforward way (Bocquet-Appel and Degioanni, 2013). It is generally considered, however, that the Neandertal metapopulation was rather small, that it experienced several bottlenecks (Dalén et al., 2012; Reich et al., 2010) and that low population density characterized Neandertal occupation of Europe (Churchill, 2014; Dalén et al., 2012; Lahr and Foley, 2003; Roebroeks et al., 2011; Stiner et al., 1999). From the archaeological side, evaluating past demography requires drawing from parameters on the intensity of occupations at a regional and site level – number of sites per time period, various proxies of occupational intensity, patterns of radiocarbon dates and so forth (Bocquet-Appel, 2000; Bocquet-Appel and Degioanni, 2013; Conard et al., 2012; Dogandžić and McPherron, 2013; French, 2015; French and Collins, 2015; Mellars and French, 2011, 2013; Surovell and Brantingham, 2007). Linking these parameters to population estimates is not a straightforward task, largely due to issues of site sedimentation rates and erosional episodes, the character of site use, varied collection curation and report/publication practices coupled with different excavation methods (Conard et al., 2012; Dogandžić and McPherron, 2013); as such, most sites from the Balkans do not provide fully reliable data on find densities, both lithics and faunal, and consequently do not allow for data comparisons between sites across this region. This said, we will focus on the presence and absence of human occupation in a given time period assuming that factors affecting the preservation of sites are acting equally across the regions and do not represent a significant bias. Archaeological record in general increases through time; any departure from this pattens is relevant for population biogeography. Of course, further research can invalidate any pattern inferred from the current archaeological record.

5.5.1 Staying warm - No clear evidence of a refugium in MIS 4

The earliest phases of the MP (before and during MIS 6) are represented by a small number of sites. Overall, the Balkan data shows a peaks in site abundance in MIS 5 and then again in MIS 3 with an apparent interruption during MIS 4 (Fig. 4). Therefore,
Neandertal higher occupation intensities in MIS 5 and later repopulation of the Balkans in the MIS 3 conforms to the wider European pattern where the most intense Neandertal habitation is related to not only warm climatic condition but periods of low climatic fluctuations as well (Lahr and Foley, 2003; Richter, 2016; Stringer et al., 2003). In the Balkans, this may be expected even for the southern regions; for example, at Theopetra, human occupation is testified to during warm climatic periods, e.g. Last Interglacial, but there are almost none during cold events that left traces in the form of frost actions (Karkanas, 2001; Karkanas et al., 2015). Additionally, on a site-basis level, anthropogenic features can be used as indications of site use intensity. Combustion features are common at several sites in particular during earlier periods (MIS 5), e.g. Crvena stijena’s (Morley, 2007) and Theopetra’s (Karkanas, 2001; Karkanas et al., 2015; Tsartsidou et al., 2014) Last Interglacial levels with superimposed colored sublayers, whitish, reddish, blackish rich in charcoal elements, representing accumulations resulting from several burning episodes; Krapina where Gorjanovic-Kramberger observed sub-layers with fire-places and burnt bones within the 8-9 m of Krapina’s stratigraphic complex dated to MIS 5e; Lakonis I sequence dated to post-MIS 5e period, exhibits intensive use of hearths. Intense fire traces at Temnata Dupka, in contrast, are present in levels with one TL date of a later, MIS 4 stage (given the overall pattern of lack on MIS 4 occupations and the lack of more reliable chronology, this one should be taken as a caution). This pattern of a more regular use of fire in warm climatic phases is noted in southwest France as well; the explanation of this pattern, though still controversial, is that Neandertals’ lack of the technology to create fire and their reliance on natural fires that are more frequent in warm and humid conditions (Sandgathe et al., 2011).

The basic premise of the refugia hypothesis is that if a region were a refugia for humans, then their presence should be continuous regardless of the climatic conditions; more specifically, even during the cold climate human populations would occupy the region. The observed paucity in the record of Neandertal occupation during MIS 4 fits with the MP record more generally of Europe (Davies, van Andel, et al., 2003; Stringer et al., 2003) where Neandertal populations occupied only limited regions during MIS 4 (e.g. SW France (Turq, 1999)) and are greatly reduced even in other southern refugia, Spain and Portugal (d’Errico and Sánchez Goñi, 2003).
It has been difficult to demonstrate evidence for MIS 4 occupations in the Balkans. The best cases to support MIS 4 occupations are Temnata Dupka, Crvena stijena and Klissoura. The latter two have a continuous record of human occupation across dozen of levels suggests habitation even during this stage. At Crvena stijena (XX) and Temnata Dupka (6) TL dates point to MIS 4, both associated with rich evidence of human activities, in terms of density of remains and the fire features (Ginter et al., 1992; March et al., 2017). We would like, however, to emphasize the need for a more reliable chronology at several sites and the site-specific circumstances such as stratigraphic and/or occupational hiati that would substantiate the MIS 4 occupation. Even if we accept these as reliable indicators of habitations during this cold phase, the pattern certainly appears as a drop in occupation when at least a consistent number of occupations, if not an increase, is expected if the region was a refugium during this time. Until further reliable chronology is provided our notion of MIS 4 will remain as being largely devoid of humans.

It is the southern regions of the peninsula that display stratified sites that bear the rich and continuous evidence of human habitation, examples are long sequences with over dozen of MP layers rich in finds at Crvena stijena, Klissoura, stratified site of Bioče with remarkably high artifact density. This suggests that the southern areas are more likely to represent refugia, as previously suggested for fauna, flora, and humans. But even within the Mediterranean region, there is a climatic and environmental contrast that may be decisive for the likelihood of the continuity of human occupation across different climatic phases; e.g. in Greece, it has been observed that the western areas, where water resources are more available and precipitation and therefore vegetation cover is higher in comparison to the eastern, more continental regions, have higher Paleolithic site densities (Elefanti and Marshall, 2015; Tourloukis and Harvati, 2017). In the extreme south, the Mani peninsula on Peloponese, has a relatively high number of MP locations (Tourloukis and Harvati, 2017); however, in this case this may be the result of increased research. Additionally, site’s attractiveness for habitation depended on its location, topography and immediate conditions. An avoidance of some cave sites during harsher climatic conditions may be due to their unfavorable position and location, as is suggested for Theopetra, since populations would have favored
locations in different topographic setting (Karkanas, 2001). This said, it may be plausible that the Balkan peninsula was not a refugia in its entirety, but that the refugia was confined to the southern regions. They have a relatively more suitable climate and environment than mountainous and northern areas for the uninterrupted occupations. Moreover, within these regions, there are smaller localized areas even more likely to be habitation ‘shelters’, as ‘refugia within refugia’ (Gómez and Lunt, 2007) depending on the local environmental factors (Feliner, 2011; Gómez and Lunt, 2007; Tzedakis, 2004).

5.5.2 NEANDERTAL DEMISE AND HOMO SAPIENS INTO THE BALKANS

Last decades have seen intense research on the intriguing events associated with the demise of Neandertals and the arrival of Homo sapiens from Africa into Europe. Circumstances of the population replacement, the nuances of the chronology of these events, overlap or geographical separation of the two populations, potential contact and acculturation, competition etc. have figured as some of the major debates over the past decades.

Support for the idea of temporal overlapped between these two groups comes from an analysis of radiocarbon ages across Europe which suggests that their coexistence, on a continental scale, lasted as long as 5,000 years (Higham et al., 2014) and genetic evidence of their interbreeding (Fu et al., 2014, 2015). Scenarios for the demise of Neandertals, however, most probably differed across Eurasia, and the extent of their possible encounters should be addressed on a regional/local scale (e.g., Conard et al., 2006; Jöris et al., 2011; Mallol et al., 2012; Pinhasi et al., 2011), with a consideration of the particularities of each region, and with the possibility that the MP-UP transition followed different routes and course of events across the continent. The recent interbreeding suggested by genetic evidence from the Peștera cu Oase (Romania) fossils (Fu et al., 2015; Sankararaman et al., 2012) makes the Balkans particularly interesting for investigating these questions. Here, at least, it seems that Homo sapiens directly encountered Neandertals.

Still, building a regional model of these events for the Balkans is not a straightforward task. The chronology of the last Neandertal and arriving Homo sapiens
primarily relies on radiocarbon ages, and here we are dealing with events at the limit of the method’s range, around 40-45 ka BP, where extra special care has to be taken to address issues of contamination. Thus in assessing the late presence of Neandertals, one has to expect potential outliers given that many reported samples have not been treated with the most up-to-date and rigorous pretreatment methods (i.e. ultrafiltration for bones and ABOx for charcoal). Newer methods almost invariably result in older ages (Devièse et al., 2017; Higham et al., 2006). Caution is likewise recommended when only a few samples are available from particularly critical levels given the possibility for post-depositional processes to impact the vertical integrity of stratigraphic units. Focusing on broader patterns based on solid data is a first step in building models for this period.

**No evidence of Neandertal occupation after 44/43 ka BP**

There is, however, agreement that the last occurrences of MP, representative of Neandertals, in most of Europe date to ~ 40 ka BP (Higham et al., 2014). For a long time the Balkans has figured as a region where some of the last Neandertals in Europe could be found. This idea comes from a series of radiometric ages from the site of Vindija (Croatia) (Higham et al., 2006; Serre et al., 2004; Smith et al., 1999; Wild et al., 2001) (Supplementary Table 1). Most of the dated bones originate from Level G1, a level that has been in focus for its co-occurrence of Aurignacian artifacts and Neandertal fossils. Bearing in mind significant post-depositional reworking of this level (Bruner, 2009; Karavanić and Smith, 2013; Zilhão, 2009), a more conservative approach of focusing only on the ages of the Neandertal fossils and not on the other faunal specimens (e.g. bear bones), whose association with the fossil material is unclear, is warranted. One of the Neandertal bones from G1 was directly dated to 38580-34860 BP (Higham et al., 2006). More recent data, however, has showed that this date can no longer be taken as an indication of a late Neandertal presence because the pretreatment did not remove all the contaminants. With a new single-amino acid AMS dating method of Neandertal bones from Vindija place them well before 40 ka BP, and more likely predating even ~44ka BP (Devièse et al., 2017).

Archeological evidence of a late persistence of Neandertals (after 40 ka BP) in the region is difficult to demonstrate. Radiometric dating of MP sites (Supplementary Table
1) suggest that, aside from infinite or minimum ages (e.g. Asprochaliko, Smolučka cave, Bacho Kiro), most dates fall earlier than 41-42 ka BP. A late date at Pešturina Level 3 (RTD7231, 33kaBP) is incompatible with the stratigraphy and relative position of the samples (Alex and Boaretto, 2014), and potentially represents an intrusion from Gravettian levels (Alex et al., 2019). Radiocarbon ages from this level do not indicate a MP occupation later than 43 ka BP. An ESR age of the last MP occupation at this site places it at 38.9 ± 2.5 ka BP (Blackwell et al., 2014). With this error range this age is close to AMS ages of 43-42 ka BP and cannot be considered as a reliable indicator of late Neandertal persistence. Similarly, a radiocarbon age at Mujina cave made on charcoal is several thousands year younger than dates obtained on bone from any other MP level at that site, as well as several dates on bone, pretreated with ABA method, with unexpectedly young dates (Boschian et al., 2017; Rink et al., 2002) (Supplementary Table 1) and all should be taken with caution. The most reliable chronology remains that the latest age at this site is ~43 ka BP. Likewise, a late age for the MP in Kličevica likely results from the bad collagen preservation and will be further tested (Karavanić et al., 2017).

Radiocarbon ages obtained for Bioče in Montenegro (Pavlenok et al., 2017) and the tephra deposit in the upper part of the sequence which is underneath Middle Paleolithic occupation (Vischnevskiy et al., 2019) potentially indicate late Neandertal habitations. However, the radiocarbon ages and the tephra analyses have not been reported in a satisfactory level that would provide unambiguous and reliable evidence of neandertal persistence beyond ~40ka BP.

In conclusion, not only that no MP occupation is found in sequences above the Campanian Ignimbrite tephra at 39ka BP, which can then be used as a terminus ante quem for the end of Neandertals, the evidence of Neandertal occupation after ~43 ka BP is rather scarce and for the moment rests on a couple of dates that are of questionable quality.

First Homo sapiens in the Balkans and the Associated Industries

The first fossil evidence of Homo sapiens in the region is represented by the
Peștera cu Oase (Romania) fossils, discovered out of archaeological context but with radiometric ages close to 40 ka BP (Rougier et al., 2007; Trinkaus et al., 2003). If we set aside two disputed fossils from Kent’s Cavern (Higham et al., 2011; White and Pettitt, 2012) and Grotta di Cavallo associated with Uluzzian (Benazzi et al., 2011; Zilhão et al., 2015), the Romanian fossil is the first fossil evidence of Homo sapiens in Europe. Its age is compatible with the Aurginacian, and the Aurignacian technocomplex has been identified as an archaeological signature of early Homo sapiens humans in Europe (Fig. 8).

![Location of Transitional, Initial, and Early Upper Paleolithic sites. See Table 1 for site abbreviations. Other abbreviations: BH – Sites in northern Bosnia and Herzegovina (Londa, Lušćić, Mala Gradina); RO – Sites in Romanian part of Banat (Românești-Dumbrăvița, Coșava, Tincova); Vr – sites Crvenka and At near Vršac, Sa – Šandalja, Fr – Franchti, Ba – Baranica, TT – Tabula Traiana.](image-url)
Even earlier traces of *Homo sapiens* dispersal might be indicated by a series of Initial Upper Paleolithic (IUP) industries. While new fossil discoveries or DNA from sediments will eventually resolve the question of who made the IUP, some researchers would accept the proposition that it was exclusively made by *Homo sapiens* and, therefore, that the wide spread of the IUP is a proxy for one of their first attempts in colonizing Eurasia (Bar-Yosef, 2006; Bosch et al. 2015; Douka et al. 2013; Hoffecker, 2011; Hublin, 2015; Kuhn and Zwyns, 2014; Müller et al., 2011; Richter et al., 2008; Svoboda, 2005; Tostevin, 2000). Formerly known as transitional industries, IUP assemblages incorporate MP features such as Levallois elements, flat core surfaces, and facetted platforms with prismatic blade production and a UP tool repertoire (Kuhn and Zwyns, 2014). Potential IUP industries include, in the Levant, the Emirian from the lower levels of Boker Tachtit (Marks, 1983) and the XX levels from the site of Üçagizli (Turkey) (Kuhn et al., 2009). In central Europe, the IUP is present at Bohunice and Stránská skála (Richter et al., 2008, 2009) where it is called Bohunician. These industries date around Greenland Interstadial 12 or ~47 ka cal BP (Müller et al., 2011; Richter et al., 2008, 2009), if not earlier (Nigst et al. 2012, 2014, 2019). In the Balkans, Temnata Dupka and Bacho Kiro (Kuhn and Zwyns, 2014; Teyssandier, 2008; Tsanova, 2008a) have been linked under the name Bachokirian and are considered IUP. Radiometric ages of Balkan IUP assemblages at Temnata Dupka (TD-I 4) and Bacho Kiro (Level 11) span 45-40 ka cal BP and according to the new dates at Bacho Kiro, IUP begun around 46-47 ka cal BP (Supplementary Table 2). However, it has also been stressed that the industries of Temnata Dupka and Bacho Kiro show a techno-typological continuity from the Middle to the Upper Paleolithic reflected in the transformation of Levallois method to volumetric blade production and increase in UP tool types (Tsanova, 2008b; Tsanova et al., 2012). Additionally, a transitional assemblage from Unit Ia at Lakonis I (Greece) features prismatic blade production, Levallois production of points, and some bifacial elements, similar to the Bohunician, and it is chronologically indistinguishable from the latest MP (Elefanti et al., 2006; Panagopoulou et al., 2004). There are, however, many gaps to fill to make a meaningful link between the Bohunician of central Europe (and beyond) and the Balkans. We certainly need a better agreement about what these shared technological and typological characteristics mean – are they reflecting population dispersals that could originate in the Levant or do they simply represent technological
convergences (Kuhn and Zwyns, 2014)? Second, are these technological changes associated with *Homo sapiens* or Neandertals? Finally, a more reliable chronology of the key industries from the Balkans is required to resolve these questions.

Of other transitional industries, the Uluzzian is present in the southern Balkans only at Klissoura cave (Greece) (Koumouzelis, 2001). The Uluzzian is mainly known from Italy, especially southern Italy, and is considered transitional because it maintains many MP elements, such as mainly flake (rather than blade) production with some bipolar knapping, because it exhibits new artifact forms such as lunates (microliths with backed arched retouch), UP tools, bone tools, and pigment use and because of its stratigraphic position between the MP and UP (Moroni et al., 2012; Peresani, 2008; Peresani et al., 2016). The question of who produced this industry is still an unresolved matter. Debate is currently centered on Grotta del Cavallo, in southern Italy, and whether *Homo sapiens* teeth are properly associated with the Uluzzian industry there (Benazzi et al., 2011; Zilhão et al., 2015) and on whether there is techno-typological continuity with the MP substrate (Mihailović and Whallon, 2017; Peresani, 2008, 2012; Peresani et al., 2016). The CI tephra overlies the Uluzzian at Klissoura as it does in Cavallo (Giaccio et al., 2008) and can serve as a temporal marker for Uluzzian chronology. This said, radiocarbon dates from Klissoura (Supplementary Table 2) can be considered as minimal and most likely the beginning of Uluzzian can be placed to around 45 ka cal BP (Douka et al., 2014).

Another transitional industry, Szeletian, is not securely confirmed in this region. Examples of bifacial leaf-like points are found at a handful of sites and consists of only a few pieces, e.g. one example in a disturbed level G1 at Vindija (Mirko Malez, 1979; Zilhão, 2009), one at Risovača (Serbia) (Гавела, 1969), several at Kamen (Bosnia) (Basler, 1979). It is also unclear whether industries with elongated leaf-points in Bulgaria (Muselievo, Samuilitza), that also have UP elements (Tsanova, 2008b), are related to the Szeletian.

While a more reliable association of transitional industries with fossil finds will aid the long debate about their ‘makers’ (Hublin, 2015), a more conservative view takes Aurignacian as an unquestionable indicator of *Homo sapiens*. Thorough studies in
western and central Europe have improved our knowledge not only of its chronology but also of the technological characterization of different Aurignacian variants (Bon, 2002; Teyssandier, 2003; Teyssandier et al., 2014; Tsanova and Bordes, 2003). How these variants relate to one another and whether they represent chronological phases or geographically distant but potentially contemporaneous stages of the development of Aurignacian will require additional evaluation of the chronological record (Banks, 2014; Banks et al., 2013a, 2013b; Douka et al., 2012; Higham et al., 2012, 2013). However, this said, the current knowledge of the technological character and chronology of the Aurignacian in the Balkans remains in its incipient stages.

The earliest Aurignacian presence in the Balkans is associated with the so-called Kozarnikian assemblage (Level VII at Kozarnika cave) (Sirakov et al., 2007) dated to between 43-41 ka BP (Guadelli et al., 2005). Characterized by the production of long, straight and rectilinear bladelets transformed into bladelets with alternate retouch or points with bilateral retouch, this industry corresponds to Protoaurignacian in western Europe (Bon, 2002; Le Brun-Ricalens, 2005; Le Brun-Ricalens et al., 2009) and Ahmarian in the Levant (Kuhn et al., 2009; Otte et al., 2011; Tsanova et al., 2012). On the left bank of the Danube, in Romanian Banat, several notable sites (Tincova, Românești-Dumbrăvița, Coșava) contain industries that incorporate elements of both Proto- and Early Aurignacian (Anghelinu et al., 2012; Sitlivy et al., 2012; Teyssandier, 2003). Their chronology is indicated by the average TL ages at Românești-Dumbrăvița that places the GH3 level (Protoaurignacian with some Early Aurignacian elements) at ~40.6 ± 1.5 ka (Schmidt et al., 2013). Several other Aurignacian sites (Fig. 9, Supplementary Table 2) are present in the northern areas of the peninsula. They either belong to its earlier phases in a techno-typological sense (Crvenka, At (Mihailović, 1992; Mihailović et al., 2011)) or in chronological terms (Baranica (Dimitrijević, 2011)). Some are placed generally in the EUP (Tabula Traiana cave (Borić et al., 2012)) and others in the later phases of this technocomplex (Šandalja (Karavanić, 2003), Šalitrena (Mihailović, 2013; Mihailović and Mihailović, 2014), and several sites in northern Bosnia (Basler, 1979; Montet-White, 1992; Montet-White et al., 1986).

Tephra layers attributed to the CI eruption can serve as a chronostratigraphic marker for these industries. The radiometric chronology of the IUP/EUP at Temanta
Dupka and its position under the CI tephra (Bluszcz et al., 1992; Fedele et al., 2003) serves as an indicator of their presence before the eruption. Transitional (Uluzzian) and EUP (Protoaurignacian) industries are found underneath the CI tephra at several sites in Italy (Fedele et al., 2003, 2008; Giaccio et al., 2006, 2008). In the Balkans this is demonstrated only with the Uluzzian at Klissoura (Koumouzelis et al., 2001; Kuhn et al., 2010).

**Fig. 9** Chronological span of late MP and early UP sites in the Balkans according to currently available ages. The $\delta^{18}$O variations from North Greenland Ice-Core Project (NGRIP) taken from [http://www.gfy.ku.dk/~www-glac/data/gripdelta.dat](http://www.gfy.ku.dk/~www-glac/data/gripdelta.dat). Greenland stadials (GS) are marked in blue and Greenland interstadials (GIS) in red. The red line indicates the time of the Campanian Ignimbrite (CI) and the blue bands Heinrich Events 4 (H4) and 5 (H5). See Supplementary Table 1 for more details. Orange circle – age of a modern human fossil from Peștera cu Oase. Uluzzian age estimate based on Klissoura, IUP/Transitional based on Bacho Kiro and Temnata Dupka, and Protoaurignacian age on Kozarnika and Românești-Dumbrăvița.
2010). EUP artifacts appear within a CI tephra layer at Franchthi (Douka et al., 2011), but that should not be taken as a demonstration of the presence of EUP before this event. A cryptotephra layer has been reported within UP layers at Kozarnika (Lowe et al., 2012), but no data is presented to indicate the exact position of the tephra relative to the industries. Non-diagnostic EUP artifacts are found within CI cryptotephra at Tabula Traiana cave and Golema Pest (Lowe et al., 2012). Significant caution, however, should be taken when using cryptotephra and non-diagnostic assemblages to build chronostratigraphic models.

**Population Replacement Scenarios**

Significant climatic fluctuations characterize MIS 3, when the gradual disappearance of Neanderthals coincided with the arrival of *Homo sapiens* in Europe. It has been claimed that the last Neandertal populations contracted their ranges to the southern refugia (Bailey et al., 2008; Finlayson et al., 2006; Jennings et al., 2011; Zilhão et al., 2010) and to cryptic refugia in the north, e.g. Belgium (Semal et al., 2009; Stewart and Stringer, 2012) when *Homo sapiens* entered Europe. Unstable climatic conditions during MIS 3 and harsh climatic episodes of HEs might have severely affected Neandertal habitat, depleted their populations, and ultimately have acted as the leading driver of their extinction. The CI eruption at 39,280 ± 110 yr BP and the severe HE4 certainly left a tremendous effect on the climate and environment of SE Europe (Fedele et al., 2003; Fitzsimmons et al., 2013). As argued above, it seems that in the Balkans anyway, the MP ended before this eruption. Their gradual disappearance might have started earlier, namely during the HE5 at 48 ka BP (Müller et al., 2011). In the Carpathian region, in particular, climatic conditions in MIS 3 caused Neandertal depopulation while facilitating *Homo sapiens* repopulation of the region (Staubwasser et al., 2018). However, there are claims that at least in this region, HE5 event may not have been as dramatic as in the western Europe (Fitzsimmons et al., 2013).

Genetic (Fu et al., 2015; Green et al., 2010; Prüfer et al., 2014) and morphological (Smith et al., 2005, 2016) evidence suggests contact and interaction of the two
populations. Archaeological evidence is, however, rare. Association of Neandertal fossils and antler points in Vindija G1 level is still debated and most likely a result of post-depositional mixing (Bruner, 2009; Karavanić and Smith, 1998; Smith et al., 2005, 2016). The Uluzzian (d’Errico et al., 2011) and IUP (Bacho Kiro) (Kozlowski et al., 1982; Tsanova, 2008a), both associated with *Homo sapiens*, feature bone industries and ornaments. It still remains unclear whether there was contact and interaction between the populations in this region.

Understanding population replacement during this time period is contingent on chronology, the question who made the IUP and transitional industries, and how spatially distributed the populations were across the region. The record will be reviewed with respect to the main regions of the peninsula (northern river valleys, central mountainous region, and southern coast).

Regarding the spatial extent of *Homo sapiens* dispersals, conspicuous is the geographical distribution of UP sites (Fig. 9). The IUP, for the moment, is represented at only two sites in the north of peninsula. The EUP (Aurignacian) is likewise evidenced in the northern regions, along the Danube corridor, as expected according to models that see the Danube as a migration route from east to west (Conard and Bolus, 2003; Kozlowski, 1992). Transitional (Uluzzian) and UP assemblages located along the southern coastal route, but, with the current state of research, only in Greece and not further to the north along the Adriatic (Karavanić, 2009).

In the *north of peninsula*, along the Danube valley, chronological overlap with Neandertals is a likely scenario, given that *Homo sapiens* made the Bohunician/Bachokirian industries and entered Europe during the Greenland Interstadial 14/13, well before 46 ka BP. Most dates indicate Neandertals had their end by at least ~41 ka BP and more likely around 43-44 ka BP. This implies that Neandertals were still inhabiting the region during the IUP occupations at Bacho Kiro and Temnata.

If we take a conservative approach and take into consideration *Homo sapiens* fossils and EUP industries, the overlap is less apparent. Ages of the last Neandertal occupations in the peninsula correspond to the ages of the EUP (Protoaurignacian at
It has been hypothesized, given the distribution of MP and Aurignacian sites in the Balkans that there was a geographical segregation of the two populations, where Neandertals lived in the mountainous regions of the Balkans and *Homo sapiens* settling the river routes, with both populations maintaining their territoriality (Mihailović, 2004; Mihailović and Mihailović, 2014). But the question of overlap rests on the nuances of the radiocarbon ages and, for the moment, we lack high resolution dating across the region. Unless new, more precise, accurate and reliable dates undoubtedly demonstrate the temporal overlap of Aurignacian, even Protoaurignacian phases, and last MP, this scenario may not be supported.

IUP, however, is chronologically synchronous with the MP. In this case, Neandertal demise might have been associated with competition with the incoming population, eventually suggesting that the combined effect of climate and competition had decisive effect on their demise. Depending on different population characteristics of both Neandertals and *Homo sapiens*, such as size and aggregation, two models of population interaction have been recently proposed: with strong demographic potential of *Homo sapiens* Neandertals would have retracted away from the low elevation areas inhabited by the newcomers and into the mountainous areas, alternatively, acculturation of Neandertals, reflected in transitional industries, would have been possible with low demographic potential of *Homo sapiens* (Mihailović, 2019). The population replacement events in this area include the overlap of the two populations, but understanding the character and dynamics of their interactions certainly requires further data and analyses.

In the *south of the peninsula*, along the Mediterranean coast, the MP ends by 43-41 ka BP, and its last phases are contemporaneous with the Uluzzian at Klissoura. No site with this industry has been thus far found on the Adriatic coast, though it is assumed that it represents a phenomenon that should link north Italian coast and Greece (Peresani, 2008). The fossil association of this industry with modern humans has been challenged (Zilhão et al., 2015) and the techno-typological assessment rather sees the continuity between the MP and Uluzzian industries (Mihailović and Whallon, 2017; Peresani, 2012; Peresani et al., 2016). Again, the population replacement scenario depends on the issue of the Uluzzian makers; if made by modern humans, the temporal
overlap would support the idea that the UP elements in Mousterian are a result of acculturation, a scenario possible with low demographic potential of *Homo sapiens* (Mihailović, 2019). Alternatively, novel elements in Uluzzian represent independent Neandertal innovations within Mousterian (Peresani et al. 2016, Mihailović and Whallon, 2017). This scenario would also be supported by the current record that indicates the lack of coexistence of Neandertals and EUP *Homo sapiens* in the maritime region and a disassociation of Neandertal demise with new populations in the area. Furthermore, this area was devoid of humans and largely depopulated since the disappearance of Neandertals. The proximity to the origin of CI eruption and the severe conditions that followed might have had an impact of the human survival. Only after several millennia we see repopulation of the area by EUP populations inhabiting the region, as evidenced by Šandalja (Karavanić, 2003), sites in Albania (Hauck et al., 2016), Franchthi, Kolomnitsa (Darlas and Psathi, 2016).

Spatial distribution of populations provides additional insights about the occupational history during this time period. Transitional and EUP industries cluster in two areas – southern coastal regions with transitional (Uluzzian) and EUP (Fig. 9), and in the northern areas, IUP and EUP sites are distributed in the low hill ranges along the valleys of Sava, Danube and their tributaries in the north of the peninsula (Fig. 9) (Karavanić, 2009; Mihailović et al., 2011). The central mountainous regions are devoid of sites with EUP, and stratified sites typically show sequences that show a gap from MP to the Gravettian (Mihailović et al., 2011). The two only sites with IUP (Bachokirian) present in the Balkans are likewise located in the same area, suggesting similar dispersal routes and settlement areas of *Homo sapiens* at different times. Unless site preservation is an issue, IUP sites are rather rare which raises the question of the intensity of these dispersals and the level of permanency of their settlements, potentially representing the “pioneer” colonization (Davies, 2007).

Still, the distribution of Aurignacian sites is rather conspicuous. We may speculate the reason why they occupied only particular geographical and/or ecological zones. We could rule out the possibility that, at least in the Balkans, it results from the territorial segregation with Neandertals, given that there was no long term coexistence of the two populations in the region and the fact that the Aurignacian never entered
mountainous region even several millenia after Neandertals disappeared. The location of Balkan Aurignacian settlements, along the river valleys, in low elevation locations, is in accordance with the observed preference for fluvial environments of EUP sites elsewhere in Europe (Davies, 2007; Hauck et al., 2018; Hussain and Floss, 2015). Their settlements rarely inhabited higher elevations (except high altitude locations of Potočka zijalka and Mokriška jama in Slovenia). We may assume that the reason for their geographical, topographical, and environmental preference does not lie in the segregation and competition with other populations but rather in landscape choices that are related to settlement systems that would facilitate settling in new environments (Hussain and Floss, 2015). It is unusual, though, that the east Adriatic coast shows a near absence of EUP sites, particularly since Aurignacian settlements may have favored littoral environments. This, however, may also stem from the fact that most of the low elevation areas – the seeming preference of Aurignacian habitation – in the great Adriatic plain were then submerged under water and sites almost impossible to discover (but see Karavanić et al., 2014, 2016).

5.6 DIRECTIONS FOR FUTURE RESEARCH ON HOMININ BIOGEOGRAPHY IN THE BALKANS

The hitherto position of the Balkan peninsula as a region with a disproportionately sparse Pleistocene record relative to its large territory, is changing slowly, thanks to the new research intensified in the last decades with an attempt to discover Pleistocene stratified locations as well as any open-air locations with surface finds and thanks to research conducted in many countries, e.g. in Serbia (Dogandžić et al., 2014; Kuhn et al., 2014; D Mihailović et al., 2014; Mihailović, 2008), Greece (Panagopoulou et al., 2015; Tourloukis et al., 2016), Croatia (Karavanić et al., 2016).

One of the main questions to be addressed in the future work is the intensity of human occupations and the role of geography, topography, and environment in human habitat choice. Within the topic of refugia during the climatic cycles, it becomes important to evaluate whether the whole region was equally occupied, if some areas were discontinuously inhabited or deserted during harsher conditions. Before applying
archaeological proxies it becomes necessary to firstly eliminate research bias and geological gaps; and this is feasible only with extended research (e.g., Tourloukis and Harvati, 2017).

The Pleistocene record at hand, however, offers several premises about human occupation with regard to geography and site preference that could be further explored. What differentiates MP occupation patterns compared to LP and UP is the almost regular habitation of mountainous areas of mid- and high-altitude areas, often at sites that lack any LP or early UP occupations (Karavanic, 2000; Mihailovic and Mihailovic, 2009; Tourloukis and Harvati, 2017), even though many MP deposits are located at stratified sites in regions of milder topography. Most of these areas remained largely unexplored and they certainly bear relevance for two research avenues: the role of refugia and habitat preference with regard to mobility and subsistence practices of Neandertals.

On the two other ends of the chronological spectrum, the LP and UP demonstrate almost a clear preference for topographically/environmentally different habitats. The lack of settlements LP-MP transition (>200 ka) in the karstic areas is apparent in many regions in Europe, with locations of human habitation in low elevations in river terraces (Hopkinson, 2007). This pattern is further corroborated by the recent findings of LP surface finds in Serbia (D Mihailović et al., 2014; Mihailović and Bogićević, 2016), and an open-air site in Greece dates to MIS 14 or MIS 16 (Panagopoulou et al., 2015, 2018). Some gaps, however, could be expected due to geological factors; for instance, long loess sequences in northern areas have accumulated over deposits containing LP occupation (Romanowska, 2012).

Littoral contexts are favored in the early UP as well (northern river valleys and the Mediterranean coast), as a consequence of populations dispersing along the river corridors and/or the particularities of their settlement and mobility patterns. Aside from the large Danube valley, other river valley running in south-north direction (Marica-Nisava, Vardar-Morava corridors) should be considered as migration routes (Mihailović, 2019). Thus, the focus of the new research (survey) endeavors targeting this time period should be placed in geomorphological and topographic aspects that include
low elevations, drainage catchments, and lakes. Furthermore, it has been proposed that dense and continuous presence of humans is evident in several regions in Europe with prevalent topographies of river valleys and lowlands with diverse resources (valleys of Dordogne and Vezere in southwest France, Ardennes in Belgium, and the Middle Danube basin), and are positioned in the central areas of the continent, where the northern and southern environmental and climatic regions overlap (Davies, Valdes, Ross and Van Andel, 2003; Stewart, 2005). In the Balkans, those favorable conditions could be identified in the northern plains with rich water resources and in southern maritime areas with almost continuous forest presence. Locating ‘attractive’ regions with diverse and/or favorable ecological conditions could be a guidance in the process of locating stratified sites. The potential locations are where the northern river valleys meet the mountainous hilly regions, and, eventually, where most of the stratified sites have been found. For example, the Morava river valley is one of the potential areas (Dogandžić et al., 2014), since, even nowadays, it has a higher average annual temperature than the hilly regions (Ducić and Radovanović, 2005).

5.7 Conclusion

Compared to the other regions of Europe, the MP record of the Balkans is inadequate for confidently building large-scale interpretations of Neandertal adaptations. The obvious impediment to a clearer understanding of Middle Paleolithic variation in the Balkans is the relative scarcity of sites over a large territory. The review presented here provides a provisional model of the variation of MP industries based on occurrences and frequencies of techno-typological elements. Such broad trends can be very informative (e.g., Monnier and Missal, 2014) and appropriate for building preliminary models of industrial variation in the region where the resolution of data and chronology is rather low. This, and the obstacles involved in the study based on a literature review, will make these models remain rather tentative. Most ideas presented here should take the form of hypotheses and provide a direction for further in depth research.

We would like to underscore several points stemming from this review. Techno-typological variability of the Balkan MP appears to follow certain temporal trends. The
earliest MP phenomena, evident even before MIS 6, are related to the wide use of scrapers and the production of thick blanks, bearing similarities to Quina technological behavior. This is followed by the introduction and extensive use of Levallois technology starting from MIS 6 and a comparable importance of scraper production, tool modification, and various levels of resharpening. Similar trends are observed in SW France, but in the east as well (e.g., Karain). Once these technological methods entered the techno-typological repertoire, they became building blocks of MP variability and were used throughout the early glacial.

MIS 5 industries demonstrate blank production that is more frequently organized towards the production of Levallois elements, production of elongated blanks, and a parallel use of the production of thick blanks, all geared for scraper production. The late MP, however, sees a decline in the use of these strategies. Flaking methods were not necessarily directed towards Levallois or Quina-like blank production, but rather employ informal radial and discoidal methods, blanks were less likely to be retouched into scrapers, and at many sites denticulates abound. The degree of occurrence of denticulate tools depends on taphonomic factors as well, and it is advised to evaluate the edge damage frequencies resulting from taphonomic processes before inferring typological character of each assemblage. It is notable, however, that many late MP assemblages exhibit higher numbers of these tool types, especially since it appears within a general trend where scrapers are a less frequent tool type compared to earlier assemblages and where more tools feature lightly invasive retouch.

Regional differences in the variation of MP industries in the Balkans are moderately pronounced. One noticeable contrast is along the east-west axis. In the east of the peninsula Quina-like methods of thick blank production have not been observed. Furthermore, industries with a high incidence of the production of bifacial products are mainly known from the east of the peninsula (Bulgaria). Additionally, a north-south distinction is observed as well – isolated bifacial pieces are found along the northern valleys of the entire peninsula but not in the inland or the south. This geographical pattern is visible across the continent where industries with bifacial tools appear in the northern regions (Bosinski, 1967; Jöris, 2004; Ruebens, 2013).
The Balkans has a unique potential for examining broader trends in the variation of MP industries at larger, interregional scales (Dibble, 1991), as it provides a valuable link between the rich and well studied regions SW Asia and western Europe. Scraper rich assemblages with the shifting strategies between Levallois or Quina-like systems that give way to more expedient methods and less reliance on scrapers is a trend also observed in SW France, for instance. Are there any underlying mechanisms in the observed similarities between these assemblages that are geographically apart? Do these trends transcend local factors responsible for the variations in industries?

Technological fluctuations during the MP did not necessarily involve innovations, but the recurrence of the primary flaking possibilities, methods that are constituting part of the MP package (White and Pettitt, 1995). Certain chronological dynamism in the shifts in the use of flaking methods is apparent in most parts of Europe (Delagnes and Meignen, 2006; Meignen et al., 2009; Monnier and Missal, 2014; Pettitt, 2003; Rolland, 1977). The following task for the Balkans is to correlate lithic variability with faunal, environmental, and climatic studies, and to explore subsistence and mobility to understand the recurrence/reappearance of techno-economic solutions.

Understanding the biogeography of the Balkans is tightly related to the question of a refugial character of this region. The available record suggests the peninsula has been largely depopulated during MIS 4, rather than being a refugium for human populations during that harsh climatic period. Their late persistence in this region, longer than in other regions in Europe, during the time Homo sapiens entered the continent, cannot be confirmed for the moment. Given the data available thus far, Neandertals disappeared around 43-42 ka BP, if not even earlier. The influence of climatic conditions can be called upon. Did they make it through the H5 or did this relatively short event cause a demographic vacuum leaving room for the arrival of modern humans? The Paleolithic of the Balkans has an important role to play in these matters. Along the river valleys in the north of the peninsula there are IUP sites that overlap with the late MP. The same ecological zone was inhabited during the EUP at the time or soon after the Neandertals disappeared in the region. Uluzzian components are present in the late MP in the south of the peninsula and the emergence of the UP seems rather late in this area. The observed patterns open several population
replacement scenarios, but a reexamination of the Balkan industries and the new investigations will shed more light on these processes.

This paper aimed to offer a comprehensive view of the MP in the Balkans. It hoped to draw attention to the Balkan MP and underline its relevance for the understanding of Neandertal adaptations in Europe. A region-wide critical disentanglement of major technological and typological trends from spatial and temporal perspectives will hopefully help put back the Balkans in the map of the European MP.
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SUPPLEMENTARY TABLES
Radiometric Ages for Middle and Upper Paleolithic Sites in the Balkans

Table SI: 1: Radiometric ages for Middle Paleolithic sites in the Balkans. Calibrated ages are reported as calBP, with 95.4%, calculated using IntCal13 calibration curve in OxCal ([https://c14.arch.ox.ac.uk/oxcal/OxCal.html](https://c14.arch.ox.ac.uk/oxcal/OxCal.html)). * Mean ages for several ESR subsamples. EU = Early Uptake for ESR ages, LU = Linear Uptake for ESR ages

<table>
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<th>Level</th>
<th>Method</th>
<th>Age</th>
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<td>C14</td>
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<td>Calibrated 95.4% (for C14 ages)</td>
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<td>(Huxtable et al., 1992)</td>
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### Mala Balanica

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### Mališina stijena

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### Mujina cave

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<td>(Alex et al., 2019; Alex and Boaretto, 2014)</td>
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<td>45170-43080</td>
<td>(Alex et al., 2019; Alex and Boaretto, 2014)</td>
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<td>2012PES50a (AT22)</td>
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<td>Mean (AT24, AT32)</td>
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1 C14 are excluded since the charcoal used for dating has been diagenetically altered and contaminated (Facorellis et al., 2013)
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Table SI2: Radiocarbon ages for the Transitional industries (Uluzzian), Initial, and Early Upper Paleolithic and AMH fossils in the Balkans.
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<th>Age Code</th>
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<td>C14</td>
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<td>(Hedges et al., 1994)</td>
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<td>IUP</td>
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