Chapter 10
Recent Research on the Croatian Middle/Upper Paleolithic Interface in the Context of Central and Southeast Europe

Ivor Karavanić, Rajna Šošić-Klindžić, James C.M. Ahern, Natalija Čondić, Ivor Janković, Krunoslav Zubčić, and Fred H. Smith

Abstract This chapter presents some new data on, and interpretations of the Croatian Middle and Early Upper Paleolithic. Alternative interpretations of the Middle/Upper Paleolithic interface in Vindija cave (situated in the Zagorje region of northwestern Croatia) are reported, together with preliminary results of research on the early Upper Paleolithic site of Bukovac pećina (situated in the region of Gorski kotar), and the late Dalmatian Middle Paleolithic sites of Mujina pećina, Velika pećina in Kličevica and Kaštel Štafilić—Resnik. The archaeological assemblage (Mousterian industry) and the results of chronometric dating make the sequences of these Dalmatian sites contemporary with late Neandertals and with the earliest known anatomically modern human groups in Europe. This recent research greatly contributes to our understanding of the distribution of Neandertals and the complexity of the Middle/Upper Paleolithic interface.

Keywords Mousterian • Aurignacian • Neandertals • Early modern humans

Introduction

Paleoanthropological, archeological, and genetic evidence from the Croatian Middle Paleolithic sites has played an important role in scientific debates about later human evolution, Neandertal adaptation, and the origins of anatomically modern humans. Despite the importance and relative abundance of the Croatian Paleolithic record, several gaps still remain. This chapter presents alternative interpretations of the Middle/Upper Paleolithic interface in Vindija, as well as preliminary results of the research conducted at Bukovac pećina in the Gorski kotar region and from three Dalmatian Middle Paleolithic sites. These sites are important for the reconstruction and comparison of behavioral processes between Central and Southeast (SE) Europe during the late Middle Paleolithic and/or early Upper Paleolithic.

The Paleolithic sites of Croatia are generally situated in two main geographic regions: continental (Hrvatsko zagorje,

I. Karavanić (✉)
Department of Archaeology, Faculty of Humanities and Social Sciences, University of Zagreb, Ivana Lučića 3, HR-10000 Zagreb, Croatia

Department of Anthropology, University of Wyoming, 1000 E. University Ave, Laramie, WY, 82071 USA
e-mail: ikaravan@ffzg.hr

R. Šošić-Klindžić
Department of Archaeology, Faculty of Humanities and Social Sciences, University of Zagreb, Ivana Lučića 3, HR-10000 Zagreb, Croatia

J.C.M. Ahern
Department of Anthropology, University of Wyoming, Laramie, WY 82071, USA
e-mail: rsosic@ffzg.hr; JAhern@uwyo.edu

N. Čondić
Archaeological Museum Zadar, Trg opatice Čike 1, HR-23000 Zadar, Croatia
e-mail: ncondic@amzd.hr

I. Janković
Institute for Anthropological Research, Gajeva 32 HR-10000 Zagreb, Croatia

Department of Anthropology, University of Wyoming, Laramie, WY 82071, USA
e-mail: ivor@inantro.hr

K. Zubčić
Croatian Conservation Institute, Mesnička 49, HR-10000 Zagreb, Croatia
e-mail: kruno.zubcic@gmail.com

F.H. Smith
Department of Sociology and Anthropology, Illinois State University, Bloomington-Normal, IL 61790, USA
e-mail: fsmith@ilstu.edu

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Gorski kotar, Lika) and Adriatic (Istria, Kvarner, Dalmatia). The most famous sites are Krapina and Vindija, located in the continental region of the Hrvatsko zagorje (northwestern Croatia), which differ geographically and ecologically from the Mediterranean sites found farther south on the Adriatic coast and its hinterland (Fig. 10.1). Human fossil remains and Paleolithic industries from these two sites have been analyzed and described in many publications (see Smith 1976; Simek and Smith 1997; Wolpoff 1999; Cartmill and Smith 2009 and references therein; also Janković et al. 2016). The Vindija cave, in particular, has yielded both Middle and Upper Paleolithic stratigraphic units that have had an important role in the debate surrounding the European Middle/Upper Paleolithic transition.

In addition to these famous sites, a few other localities are known from continental Croatia. The site of Velika pećina, also in the Zagorje region, was initially best known for a human frontal bone thought to be associated with the early Upper Paleolithic at the site (see Smith 1984), but later shown to be intrusive into the Upper Paleolithic strata (Smith et al. 1999). However, the site has yielded a small series of artifacts, including bone points, that are clearly derived from the early Upper Paleolithic (Malez and Vogel 1970; Karavanić and Smith 1998). About 100 years ago a single bone point was found at Bukovac pećina situated in the continental region of Gorski kotar, located between the Hrvatsko zagorje and the Adriatic (Malez 1979; Fig. 10.1). Based solely on that bone point, this site was designated an early Upper Paleolithic locality. However, the lack of corroborating finds makes this attribution questionable. Recent excavations carried out in 2010–2012 in this cave aimed to determine the layer from which the bone point originated and to obtain samples from that level for dating (Janković et al. 2011b, 2016).

In contrast to Hrvatsko zagorje, the cultural and paleoecological situation in Dalmatia (southern Croatia) is not as extensively known. Until recently, Paleolithic research in this region was rare. Archaeological material was mainly collected from the surface of open-air sites and determination was based solely on typology (Batović 1965, 1973, 1988; Vujević 2007). Many pseudoartifacts, pseudotools, and naturally fragmented pieces were found together with artifacts and tools, sometimes in mixed cultural contexts. The only site in Dalmatia with a clear and homogenous Mousterian stratigraphic sequence that was excavated systematically (1995–2003) is Mujina pećina near the city of Kaštela. Radiocarbon AMS and ESR dates obtained from Mujina pećina are the first chronometric dates for the Mousterian industry in Dalmatia (Rink et al. 2002). A test excavation of another Dalmatian site, Velika pećina in Kličevica near Benkovac, was conducted in 2006 (Karavanić et al. 2007; Karavanić 2008). More extensive excavation was carried out in 2012 and 2013, establishing a short stratigraphic sequence, with several layers yielding numerous Mousterian finds. Furthermore, small-scale excavation at the underwater open-air Mousterian site of Kaštel Štafilić—Resnik, using a grid, was conducted in 2008 and continued through 2010–2013, when only surface finds were collected over a larger area (Karavanić et al. 2009).

The Istrian peninsula is home to several Paleolithic sites, but these have yielded mostly later Upper Paleolithic occurrences. Exceptions are lower layers (H—E) from the site of Šandalja II which have produced Aurignacian artifacts (see Malez 1979; Karavanić 2009). Except for Šandalja II, only one other possible Aurignacian (Ivšišće) and two Mousterian sites (Romualdova pećina and Campanož) are known from the Istrian region of Croatia (Komšo et al. 2007; Komšo 2012).

Sites

Vindija

Vindija cave is a Middle and Upper Paleolithic site (with Holocene archaeological deposits as well), in which Neandertal skeletal remains were found (Malez 1975; Malez et al. 1980; Wolpoff et al. 1981; Janković et al. 2016). The site is situated 2 km west of the village of Donja Voća, and 20 km west of Varaždin. Its entrance lies in a narrow gorge 275 m above sea level. The cave is more than 50 m deep, up to 28 m wide and more than 10 m high at some places (Fig. 10.2). Vuković (1950), who first visited the site in 1928, excavated the cave for more than 30 years, with some interruptions. Malez started systematic excavations at Vindija in 1974, and fieldwork continued every season until 1986. Most of the lithic and faunal material, as well as all of the fossil human remains known from the site, were recovered during this latter period (Ahern et al 2004; Janković et al. 2006, 2011a). The stratigraphic profile, which is about 9 m high, comprises some 20 strata that, according to Malez and Rukavina (1979), covered the period from the onset of the Riss glaciation (oxygen isotope stage 6 or earlier) through the Holocene. The G complex, comprising five stratigraphic levels numbered G_1 (top) through G_5, produced all of the Neandertal skeletal remains from the site (although one or two fragmentary pieces may derive from earlier levels, cf., Ahern et al. 2004). Level G_3 contained approximately 100 fragmentary Neandertal skeletal remains associated with a late Mousterian industry. These remains were directly dated to >42 kBP (uncalibrated) by radiocarbon AMS (Krings et al. 2000) and 4 years later to *ca.* 38 kBP (uncalibrated) by the same method (Serre et al. 2004). An additional AMS radiocarbon date on a Neandertal bone from unit G (level unknown) has yielded results of about 44 kBP (uncalibrated; Green et al. 2010; for other dates see Wild et al. 2001; Ahern et al. 2004: Table 1).

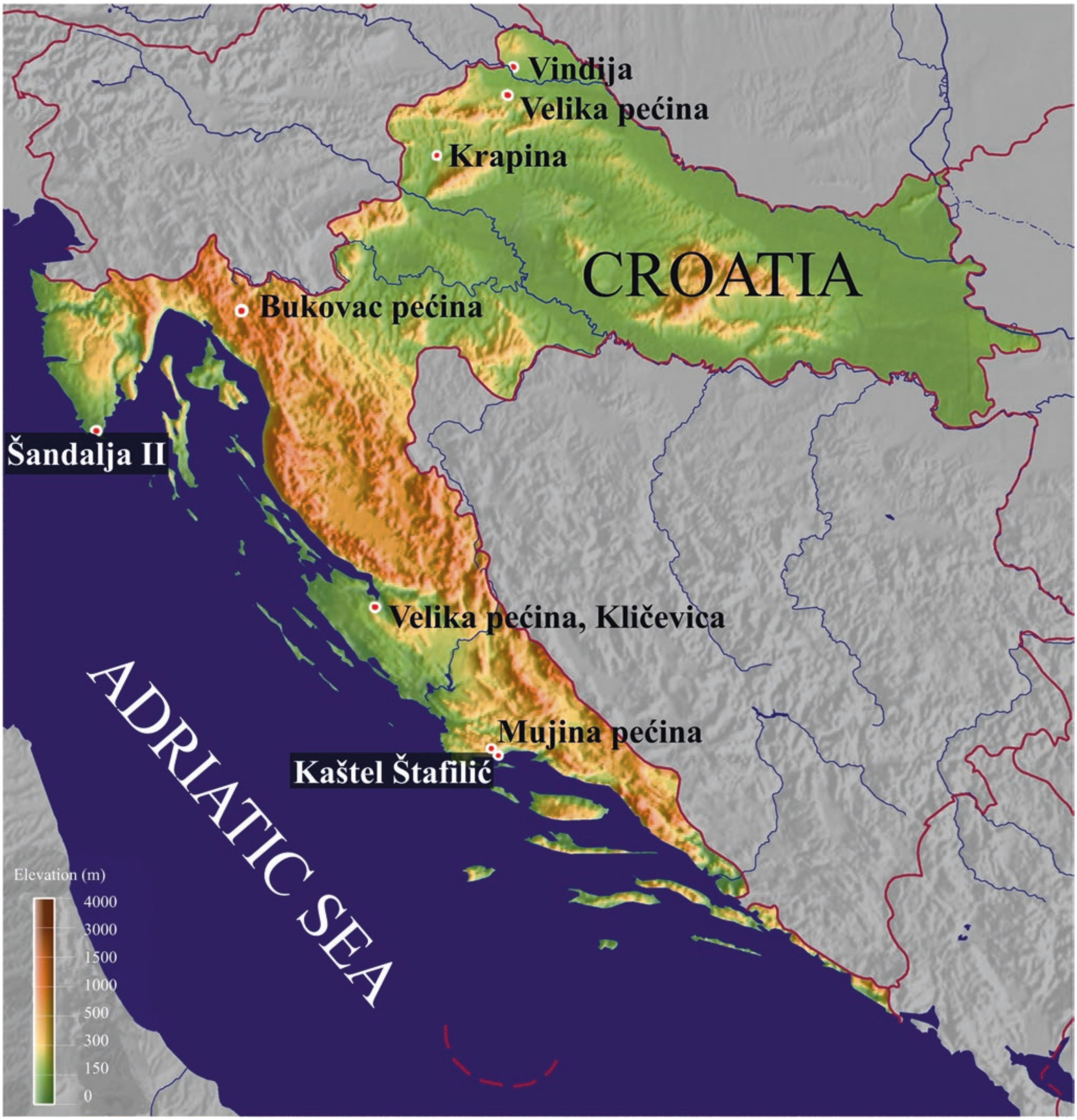

Fig. 10.1 Map with most important Croatian sites mentioned in the text. Downloaded from GinkgoMaps-project, http://www.ginkgomaps.com licensed under CC-BY-3.0, modified by: M. Vuković

A series of human skeletal remains derive from level G_1 and diagnostic morphology from these specimens identifies them as Neandertals (Smith and Ahern 1994; Smith et al. 1999; Ahern et al. 2004). Several different radiocarbon dates on bone samples from this level have been obtained (see Ahern et al. 2004: Table 1). The most important are direct AMS dates from Neandertal skeletal remains, specifically the Vi 207 mandible and 208 parietal. These bones were first dated to 28 and 29 ^{14}C kBP, respectively (Smith et al. 1999). More recently, however, the same samples were redated, using ultrafiltration pretreatment, to 32.4 ± 0.8 ^{14}C kBP, 31.4 ± 0.2 ^{14}C kBP, and 32.4 ± 1.8 ^{14}C kBP, respectively (Higham et al. 2006). Since these dates are uncalibrated, the calibrated age would be older.

Neandertal skeletal remains from level G_3 show distinct changes in facial morphology compared to earlier Neandertals;

Fig. 10.2 View from inside Vindija cave. Photo I. Karavanić

these differences characterize the entire G_3 Vindija sample, not just selected specimens (see Smith 1984; Wolpoff 1999; Ahern et al. 2004; Cartmill and Smith 2009; Janković et al. 2016). The small sample of Neandertals from level G_1 shows the same basic morphological characteristics as those from comparable elements in the G_3 sample (Wolpoff et al. 1981; Smith and Ahern 1994; Smith et al. 1999). In these features, the Vindija G_3 and G_1 specimens are intermediate between the geologically earlier Krapina (and most other) Neandertals and early modern Europeans, although still closer overall to the former group (Smith 1994; Karavanić and Smith 1998; Cartmill and Smith 2009).

The Vindija faunal remains were studied on several occasions (Miracle 1991; Brajković 2005; Brajković and Miracle 2008; Karavanić and Patou-Mathis 2009). Results from both faunal and stable isotope analysis show that the Vindija Neandertals were top-level carnivores, obtaining almost all of their dietary protein from animal sources (Richards et al. 2000; Karavanić and Patou-Mathis 2009). In this respect, the Vindija people are similar to Neandertals from other parts of Europe (e.g., Bocherens and Drucker 2006; Bocherens 2011).

The Vindija stratigraphy contains levels with both Middle (Mousterian) and Upper Paleolithic industries. In the lower Mousterian levels, tools were produced on local raw materials (Kurtanjek and Marci 1990; Blaser et al. 2002) using the Levallois method (Montet-White 1996). In contrast, the Levallois method was not used in level G_3, but local raw materials (chert, quartz, tuff, etc.) continued to be used. Seventeen percent of lithic items from G_3 were transformed into tools. This Late Mousterian industry is dominated by sidescrapers, notched pieces, and denticulates, but also contains some Upper Paleolithic types (e.g., endscrapers, see Karavanić and Smith 1998). Some endscrapers might have come from the Upper Paleolithic levels as a result of sediment mixing. However, in addition to flake technology, level G_3 includes evidence of bifacial technology and blade technology (Karavanić and Smith 1998). New analyses (Karavanić and Patou-Mathis 2009) show that some "retouchers" from the G layer (Karavanić and Šokec 2003;

Ahern et al. 2004) are in fact pseudoartifacts. Markings on a cave bear baculum (Karavanić and Smith 1998) could also be the result of natural processes and not of human activity (Karavanić and Patou-Mathis 2009).

As in level G_3, a combination of Middle and Upper Paleolithic typological characteristics is also present in the stone tool assemblage from level G_1, where various lithics, bone points, and Neandertal fossils were found. Some of the lithic items from this level, previously identified as tools, probably represent pseudotools (see Zilhão and d'Errico 1999; Janković et al. 2006: 4; Zilhão 2009). While relatively meager, the lithic industry of this level suggests continuation of the Mousterian technological and typological tradition (with the absence of the Levallois method). In contrast, the bone tools from the same level are typical of the Upper Paleolithic, and therefore, this industry was attributed to the Aurignacian (Karavanić 1995). This unusual association of Neandertal skeletal remains and Upper Paleolithic bone points in level G_1 has been explained either as a result of mixing of different strata (Kozlowski 1996; Zilhão and D'Errico 1999; Bruner 2009; Zilhão 2009), or as a true cultural assemblage (Montet-White 1996; Karavanić 1995, 2000b, 2007; Karavanić and Smith 1998, 2000; Janković et al. 2006; Karavanić and Patou-Mathis 2009).

A number of interpretations have been given for the G_1 lithic industry (e.g., Karavanić 1995, 2000b; Kozlowski 1996; Montet-White 1996; Karavanić and Smith 1998; Miracle 1998; Zilhão 2009). Kozlowski (1996) sees it as Mousterian; Svoboda (2001, 2006) has suggested affinities to the Szeletian; while Montet-White (1996) used the term Olschewian (see also Karavanić and Smith 1998). Karavanić (2000b; 2007) used the Olschewian to designate a possible regionally specific "transitional" industry. Recently, Zilhão (2009) also claimed that this industry is Szeletian. More generally, Straus (1999), Montet-White (1996), Karavanić and Smith (1998; 2011), Karavanić and Patou-Mathis (2009), Ahern et al. (2004), and Janković et al. (2006, 2011a, b) see the unusual G_1 associations in the context of a more complex pattern that characterizes the Middle/Upper Paleolithic transition in this region, as some of the so-called transitional industries that combine Mousterian and certain Upper Paleolithic technological and typological aspects are found at many localities, especially in Central Europe (for a more detailed insight and references see Janković and colleagues 2006, 2011a; Karavanić and Smith 2011).

Bukovac Pećina

Bukovac pećina is located in Croatia's Gorski kotar region, southeast of the town of Lokve on the northwestern slopes of Sleme Hill (Malez 1979). It is situated in a mountain region in the border zone between the Mediterranean and continental zones of Croatia, closer to the Adriatic than to the Hrvatsko zagorje sites (Fig. 10.1). The cave was first test excavated by Kormos (1912) and Szilágy in 1911 (Malez 1979). A trench excavated in the front of the cave yielded no significant discoveries, but a test pit deeper inside the cave resulted in the recovery of faunal remains and a bone point. The point was assigned to different cultures (Malez 1979), but today the overriding view is that it belongs to the Aurignacian or Olschewian (Malez 1979; Montet-White 1996; Horusitzky 2004). The base of the point is missing, but based on the sudden thinning of the widest part it can be argued that it was a so-called Mladeč point. No additional artifacts were recovered during the 1970s excavations by Malez (1979). Therefore, the assignment of the industry to the Upper Paleolithic on the basis of this single point might be questionable. One of the major aims of the excavations under the direction of I. Janković from 2010 to 2014 (Janković et al. 2011b), was to determine the layer from which this find originated, based on the stratigraphy provided by Kormos (1912), and to obtain material for dating (Fig. 10.3). Unpublished radiocarbon dates confirm the Aurignacian timeframe. In addition, a second artifact (a stone core) was found in a trench in front of the cave in 2013.

Velika Pećina in Kličevica

Velika pećina is located in the canyon surrounding the Kličevica creek near the town of Benkovac in Dalmatia, Southern Croatia. Savić (1984) collected several lithics from the cave and its surroundings. Malez visited the site, collected several artifacts and conducted a small-scale excavation in the cave (Savić, personal communication). Božićević (1987) published the layout of the cave and a longitudinal cross-section. Karavanić and Čondić (2006), visited the site with a small team in 2003 and collected several artifacts from the surface of the cave floor. A test excavation was conducted in 2006 (Fig. 10.4). In a small trench (1 × 2 m initially, somewhat expanded during the excavation in order to reach the cave wall) several Mousterian levels were established. A total of 105 finds were found *in situ*, among which stone artifacts dominate, while animal bones and teeth are less abundant. Additionally, a number of items were found in the sieve. Animal bones from level D were dated by radiocarbon AMS to *ca.* 39 ^{14}C kBP (Karavanić et al. 2007). Recently, an animal bone from level D was cut in two pieces and sent for AMS radiocarbon dating (Karavanić et al. 2014). Half of the bone was prepared for the AMS in the standard way, while the other half was prepared by ultrafiltration. The first sample, prepared in standard way was dated to *ca.* 35 ^{14}C kBP. The other, prepared by ultrafiltration, was dated to *ca.* 32 ^{14}C kBP (Karavanić

Fig. 10.3 Excavation at Bukovac pećina. Photo I. Karavanić

Fig. 10.4 Excavation at Velika pećina in Kličevica. Photo I. Karavanić

et al. 2014). Comparing with an earlier date from Velika pećina and the dates from Mujina pećina (Rink et al. 2002), these new dates are too recent for late Mousterian in Dalmatia (for further discussion of these dates see Karavanić et al. 2014). The tools (Fig. 10.5) are small (similar to the so-called Micromousterian), and made on local chert. Based on typology (most tools are scrapers, some of which are transversal), the artifacts represent the Late Mousterian (or Balkan Charentian according to the terminology of Kozlowski).

Excavation squares from the earlier excavations were expanded, and two additional squares were opened in 2012. In one of them the basal rock was soon unearthed, while in the other a layer yielding Mousterian artifacts and animal bones was found after a layer of mixed sediment was removed. Additional squares were opened in 2013 and further excavation of the site is planned.

Mujina Pećina

Mujina pećina is situated in the hills north of Trogir and west of Split (Fig. 10.1). The cave is about 10 m deep and 8 m wide, located at about 280 m above sea level. Finds were initially collected in 1977 from the surface inside and outside the cave (Malez 1979), and the first test excavation took place in 1978 (Petrić 1979). In 1995, a joint project of the Department of Archaeology at the University of Zagreb and the Museum of the Town of Kaštela launched systematic excavations. The last year of excavation was 2003. Following standard archaeological methodology for Paleolithic cave sites, all artifacts and ecofacts with dimensions of 2 cm or more in size were recorded in three dimensions on site plans, and all sediments were sieved (Fig. 10.6). The northern stratigraphic profile inside the cave is only about 1.5 m deep and comprises poorly sorted Quaternary sediments composed of large fragments of

Fig. 10.5 Scrapers from Velika pećina in Kličevica. Photo I. Karavanić

Fig. 10.6 Excavation at Mujina pećina. Photo S. Burić

carbonate rock, gravel and sand grains, rarely silt, and some clay (for further discussion of the stratigraphy of the site see Karavanić and Bilich-Kamenjarin 1997; Rink et al. 2002). The interface between Level E2 and E1 was dated by AMS to 45 ^{14}C kBP, while the AMS age of overlying levels, calculated as the mean of 5 dates from these levels, is about 39 ^{14}C kBP (for discussion on these and ESR dates see Rink et al. 2002).

Two localized areas of burning, probably representing open, unconstructed and unpaved Mousterian hearths, were found in the occupation level D2. Anthracotomical analysis shows that *Juniperus sp*. was used for fuel at both hearths (Culiberg, personal communication; Karavanić et al. 2008b).

All lithic finds are attributable to the Mousterian industry (Karavanić et al. 2008a, b). No human skeletal remains were recovered. However, given the nature of the lithic assemblage and the radiometric dates, it is assumed that Neandertals were responsible for the evidence of human occupation at the site. Presence of Levallois debitage was detected in levels D1 and D2. In levels B and C, tools make up 1/3 of the lithic assemblage. Of these, flakes are the dominant technological product. The most frequent tool types in these levels are denticulates and notched pieces. Tools are generally small in size (around 3 cm in length) and strongly resemble the so-called Micromousterian. Of the total lithic material from levels D1 and D2 only about 1/5 are definite tools. The most frequent tool types are simply retouched flakes, made on local chert pebbles and nodules, which are often small. It seems more likely that the use of small pebbles available near the cave, as well as the low flaking quality of larger pieces of some local cherts (rather than the intentional selection of small pebbles for production of small tools) dictated the small tool size in the Mousterian of Dalmatia (Karavanić et al. 2008a, b).

Faunal remains from Mujina pećina also show differences in dominance of animal species between these two stratigraphic complexes, especially in their frequency. The relative frequency of chamois/ibex, equids, and large-sized carnivores increases dramatically from the lower levels D1/D2 to levels B and C, while the relative frequency of hare and red deer decreases significantly (Miracle 2005). Red deer and hare are often regarded as indicative of temperate conditions, and their decrease could be interpreted as evidence of a shift towards cooler and drier climates in levels B and C. However, we believe sedimentary analyses to be a more reliable indicator of local climate. While levels D1 and D2 contain cryoclastic stone debris indicative of cold climate with some or no gravel and/or fine sediment, levels B and C contain brown sandy sediment with stone debris indicative of a relatively warm climate (Karavanić and Bilich-Kamenjarin 1997; Rink et al. 2002). Data from the fossil plant remains agree with the climatic conditions ascertained on the basis of sediment data (Karavanić et al. 2008b). The discordance between sediments and faunal assemblages therefore most likely reflects prey selection by humans and/or other bone collectors (Miracle 2005).

The frequency of large carnivores, especially bears, that used the cave for hibernation and as a nursery, suggests their more regular occupation of Mujina pećina in levels B and C relative to levels D1 and D2 (Miracle 2005). During the accumulation of levels B and C people visited the site, but their cultural remains are less numerous than in some earlier levels (E1, E2 and E3). Impact scars and cut marks are present in all analyzed levels (B+C and D1+D2) but are found only on faunal long-bone shafts, suggesting first defleshing and then cracking long bones for marrow extraction by humans. Alongside the evidence of carcass processing, the dominance of prime-age adults among red deer, chamois/ibex, and large bovid assemblages suggests hunting activities by the Mujina pećina inhabitants (Miracle 2005). There is a difference between levels B and C, and D1 and D2 reflected in animal activities in the cave. In levels D1 and D2 carnivores were scavenging human food refuse, while in the levels B and C bear activity is noticeable. The assemblage with evidence of human processing does not indicate targeting particular prey to the exclusion of other species or specialized procurement (Miracle 2005; Karavanić at al. 2008b).

The northern niche, which provided a good shelter from bad weather conditions, was the most intensively used area of the cave during the formation of stratigraphic units B, D1, D2, and E2 (Nizek and Karavanić 2012). On the other hand, most of the material from the level E1 was concentrated along the southern edge of the excavation area, while another extensively used area for levels E2 and E3 was the entrance to the cave. The oldest levels (E3, E2, E1) at Mujina pećina are richest in anthropogenic finds, indicating much more intensive human activity than in younger levels. The richest levels may suggest long-term occupation (Karavanić 2000a), but may also result from the repeated use of the site for brief occupations (see Conard 1996). The lower density of finds in the upper levels (B, D1 and D2) suggests that the site was used as an occasional hunting camp during the formation of these levels (Nizek and Karavanić 2012).

There is strong evidence that people used Mujina pećina during the autumn throughout the sequence (at least in the analyzed layers), as well as for spring visits in level B (Miracle 2005; Karavanić et al. 2008b). There is no evidence of human activities in Mujina during the summer and winter, while bears were active at the cave during the winter in level B. These observations bring up the question of where the Mujina pećina people lived during the summer and the winter. One distinct possibility is that they were closer to the coast during the winter to take advantage of seasonally migrating game and relatively warmer and more sheltered locations. If so, such locations are most likely under sea level at the present time, or were damaged and washed away by subsequent changes in sea level.

Kaštel Štafilić: Resnik

The site of Resnik is a well-known locality from the Hellenistic and late Roman periods, and finds have been collected both on land and under water (Brusić 1990, 2004). Neolithic finds also have been collected from an underwater site, but at a different location from the Hellenistic and late Roman finds (Brusić 2004). Of particular importance is the discovery of an underwater site that yielded Paleolithic artifacts. The site is located at a depth of about 4 m, and the discovery was reported by I. Svilan (Karavanić et al. 2009).

Small-scale excavation at the site of Kaštel Štafilić using a grid was conducted in 2008 (Karavanić et al. 2009) and continued in 2010–2015, when only surface finds were collected (Fig. 10.7). The methodology used is described in detail elsewhere (Karavanić 2015). The locality itself represents an open air site dating to the time when the sea level was much lower than today. Although the finds are somewhat disturbed (due to the action of waves and other factors) it seems that their accumulation is not a result of displacement from another locality as was reported earlier (Karavanić et al. 2009).

Among the tools, several pseudotools and numerous naturally broken pieces of chert were found. The excavations ascertained the presence of the centripetal method and confirmed that the artifacts (side scrapers are most abundant) belong to the Mousterian industry. The finds are not numerous enough to allow a more detailed determination of the type of Mousterian, and the question whether the site is contemporaneous to, or older than the occupation at nearby Mujina pećina remains open. There is a possibility that the same group of hunters used both sites during different seasons.

This site is important for several reasons. It adds to the overall picture of the area that was once land and connects it to other sites. It also allows for the development of a methodology for underwater excavation of Paleolithic sites, which is one of the important directions Paleolithic archaeology will take in the near future. Additionally, it opens up a whole set of questions related to the processes of formation of underwater sites.

Interpretative Summary

Late Middle and early Upper Paleolithic sites in Croatia are found in two geographical regions: continental and Adriatic. This enables us to study the adaptation of late Neandertals and early modern humans in two different paleoenvironmental settings. The most important site for the study of the Middle/Upper Paleolithic interface in northwestern Croatia is the Vindija cave, as it contains fossil remains of late Neandertals associated with artifacts. Lately, it has been claimed (Zilhão 2009) that the most recently published date of 32.4 ^{14}C kBP (Higham et al. 2006) for the Vindija G_1 layer Neandertals is likely a minimum date, and a recent study by Higham and colleagues (2014) implies the same. Zilhão (2009) further claimed that the actual age of these remains must be older in order for Vindija to support the assimilation model of modern human origins (see Smith et al. 1989, 2005; Cartmill and Smith 2009). Zilhão (2011) holds that all Neandertals and the Mousterian predate all early modern humans and the Upper Paleolithic. Thus for him, Vindija must predate any occurrence of modern humans or the Upper Paleolithic to constitute evidence of a Neandertal contribution to early modern populations.

The assimilation model posits that archaic Eurasians, including Neandertals, made small, but not insignificant, contributions to early modern human populations as the latter spread throughout Eurasia (Smith et al. 1989, 2005; Ahern et al. 2013). Interbreeding between early modern humans and Neandertals, as well as other archaic humans, has been suggested for some time based on morphological studies (see reviews in Wolpoff 1999; Smith 1994; Cartmill and Smith 2009). More recently, genetic studies have also supported interbreeding (Green et al. 2010; Sankararaman et al. 2012, 2014; Prüfer et al. 2014), although they have also shown that the Neandertal (and other archaic human) contributions to the modern human gene pool were uniformly small. Initially, Green and colleagues (2010) estimated that interbreeding between Neandertals and early moderns must have occurred before Asian and European modern populations diverged from one another, at *ca*. 100 ka. More recently, however, Sankararaman et al. (2012) found that the last genetic exchange occurred most likely between 37 and 86 ka. This range overlaps with the dates for Vindija G_3. Zilhão's (2009) assertion that Vindija has to date earlier that the first modern humans in Central Europe for the assimilation model to apply, is simply not the case. We believe that even if the Vindija G_1 dates were slightly older when calibrated, they still overlap with early modern dates such as those from the Grotta del Cavallo (Benazzi et al. 2011) and Oase (Trinkaus et al. 2003). Thus, as we explain in detail elsewhere (Karavanić and Smith 2011; Janković et al. 2011a, 2016; Ahern et al. 2013), we interpret the Vindija morphology, not as Zilhão does, but rather as an indication of modern human gene flow into a late Neandertal population. In the context of that interpretation, the younger age of Vindija makes perfect sense (contra Zilhão). It is important to reemphasize that the assertion that Vindija reflects modern human gene flow into late Neandertals is a morphological argument, not demonstrated by the current genetic evidence. Still, it seems highly unlikely that gene flow occurred in only one direction, particularly given the 6–9 % contribution of Neandertals to early modern Central Europeans (Fu et al. 2015).

Much of the debate concerning the possibility of Neandertal–early modern human interaction at Vindija is

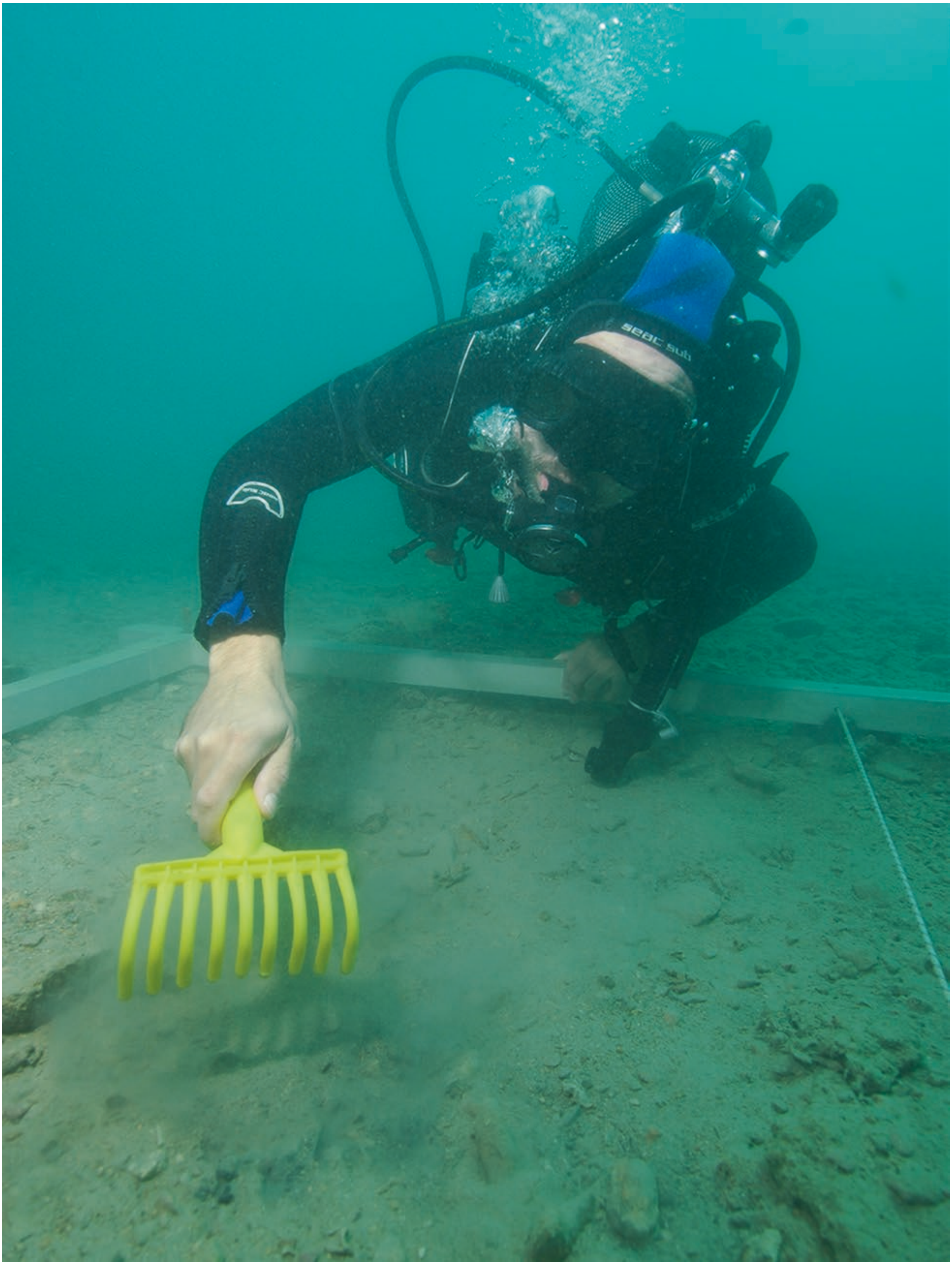

Fig. 10.7 Collecting material from the surface of underwater site Kaštel Štafilić. Photo K. Zubčić, Croatian Conservation Institute

based on the archaeological industry from level G_1. In this layer, various lithics, bone points and Neandertal skeletal remains were found, and a mixture of Middle and Upper Paleolithic typological characteristics is present in the stone tool assemblage. It is likely that some of the lithics (e.g., Vi 1061, Vi 3383) are pseudotools, as argued recently by Zilhão (2009). The presence of pseudotools and the results of refitting (Bruner 2009; Zilhão 2009) confirms that there was some mixing of different layers, and that the presence of certain Upper Paleolithic lithic tool types made on high quality silex from G_1 and G_3 layers might be explained as a result of this mixing (Karavanić and Smith 2011). Different authors have long recognized that both bioturbation and cryoturbation occurred at Vindija and likely resulted in mixing of elements from different layers in some parts of the cave (Malez and Rukavina 1975; Smith 1984; Kozlowski 1996; d'Errico et al. 1998; Karavanić and Smith 1998). However, these phenomena are not seen uniformly throughout the site, and the area where many of the relevant finds were found does not show evidence of disturbance (Karavanić and Smith 1998, 2011). Furthermore, the change in the raw material seen from early Middle Paleolithic levels to late Upper Paleolithic levels (increase in chert and decrease in quartz; see Blaser et al. 2002; Ahern et al. 2004: Table 9) is more easily explained as a reflection of behavioral change.

In light of the documented disturbance of layers, the Olschewian hypothesis regarding the transitional industry of the G_1 layer (Karavanić 2000b, 2007) is not likely. While Pacher (2010) correctly pointed out the lack of attributable elements required to define Olschewian as an Initial Upper Paleolithic industry, her suggestion that fossil human remains from Vindija level G_1 are not Neandertals has no foundation. Even though the human remains are very fragmented, as she properly noted, their anatomical features clearly indicate attribution to Neandertals with some modern human characteristics (see Smith and Ahern 1994; Karavanić and Smith 1998; Wolpoff 1999; Cartmill and Smith 2009). The attribution of the G_1 industry to the Szeletian was first proposed by Malez (1979) more than 30 years ago, although it is unclear whether he was referring to the G_1 unit specifically, or to some other G unit layer. Likewise, Svoboda (2001, 2006) noted some similarities between the G_1 layer of Vindija and the Szeletian, and, recently, Vindija G_1 was attributed to the Szeletian by Zilhão (2009). However, the evidence for the presence of the Szeletian industry in G_1 is based solely on one tool, a nicely shaped bifacial point. There is no evidence of *in situ* production of this tool, and it was made on nonlocal raw material (red radiolarite) that was imported from Hungary (Montet-White 1996; Karavanić and Smith 1998; Biró and Markó 2007).

Therefore, the best determination for the G_1 lithic industry is Mousterian (Karavanić and Smith 2011, see also Kozlowski 1996), while the Szeletian bifacial stone point should be seen as an import, the result of the contact among various Neandertal groups (if the Szeletian was produced by Neandertals) or a contact between Neandertals and early modern humans (if the Szeletian was produced by early modern humans) between northwestern Croatia and Hungary. Although most Szeletian assemblages and sites from Hungary are older than Vindija G_1 (Adams 2009), a contemporary late phase of the Szeletian is known in western Slovakia (Kaminská et al. 2011). Even though we cannot completely rule out the possibility of disturbed contexts, we argue that the Upper Paleolithic elements in the same level, especially the bone points and possibly some lithic types, may well be a result of contact (exchange or acculturation) between Neandertals and anatomically modern groups (Karavanić and Smith 2011).

Although direct dating of the bone points from Vindija and Velika pećina (both in the Hrvatsko zagorje, NW Croatia) failed (Smith et al. 1999), an age of 34 ^{14}C kBP was determined for the "i" layer of that site (Malez and Vogel 1970). Thus, the same age can be assumed for the bone points (most likely with split bases) from the same layer of the same site (Malez and Vogel 1970). A bone point (most likely with a split base) from Divje babe I (Slovenia) comes from a layer that has been dated to about 35 kBP (Nelson 1997). This point was directly dated to *ca.* 30 ^{14}C kBP (Moreau et al. 2015) while points from Potočka zijalka (Slovenia) are dated to between 35 and 29 kBP (Hofreiter and Pacher 2004; Moreau et al. 2015). The oldest bone projectile points from Hungary are dated to 37–38 kBP (Davies and Hedges 2008–2009). All of these dates are uncalibrated. Although we do not have direct dates on the points, a date from a comparable archaeological layer suggests that the bone points from Velika pećina (Hrvatsko zagorje) are older than, or contemporaneous with, the Vindija Neandertals. If we adhere to the generally accepted view that such points are associated with modern humans, this also raises the question of possible interactions between these groups.

Upper Paleolithic bone points have also been found at other Croatian sites, such as the presumed Aurignacian specimen from Bukovac cave discussed earlier. From the eastern Adriatic, only a single bone point has been found, and it comes from the layer H at the site of Šandalja II in Istria. It is relatively small compared to the points from Central Europe and has a split-base and rounded cross section. It is similar to points from the Franco-Cantabrian Magdalenian (Straus, personal communication); and based on the recent date for the layer F at Šandalja II, it should be older than 32 kBP (Richards et al. 2015), if it did not originally come from one of the Epigravettian layers. The Dalmatian area has several known Mousterian sites: open air sites with surface finds at the area of Ravni Kotari, north of Zadar; the open air site Veli Rat at the island of Dugi; the Giljanovići open air site north of Kaštela; Velika pećina in

Kličevica near Benkovac and Mujina pećina near Kaštela cave sites; and the Kaštel Štafilić—Resnik underwater site. However, to date these have not been fully investigated. Only the site of Mujina pećina has been systematically excavated. Systematic research at Kaštel Štafilić is in progress and systematic excavations of Velika pećina in Kličevica started in 2013. To date no bone points have been recovered from these localities.

It is clear that mixture of artifacts from different levels occurred at Vindija, and this fact alone casts a cloud of suspicion on the nature of the level G_1 cultural assemblage. However, given the fact that these potential examples of interaction are rare and often ephemeral, it seems wise not to entirely dismiss the Vindija evidence. For example, another site offered as evidence for Neandertal acculturation, the Gotte du Renne at Arcy-sur-Cure, has been argued, most recently by Higham and colleagues (2010) and Bar-Yosef and Bordes (2010), to show effects of disturbance resulting in mixing material from different levels. The evidence from Grotte du Renne, in the form of the Initial Upper Paleolithic Châtelperronian assemblage, extends over several archaeological levels, making extensive mixing seem unlikely (see Hublin et al. 2012). However, Vindija level G_1 is a very different story. It is a relatively thin level that is not found in all parts of the cave, and there is a reason to suspect considerable erosion of deposits from caves in Central Europe during this time span (Malez and Rukavina 1979). Thus, the nature of G_1 as an archaeological level, plus the obvious presence of cave bear in the cave, makes it difficult to conclusively demonstrate that mixing of layers did not occur.

Still there is some evidence against the argument that mixing explains all the interesting associations in Vindija level G_1. First of all, there is no evidence that the Neandertal skeletal material in G_1 originates from another level. The fragmentary cranial material from the younger F complex is basically modern (Smith et al. 1985) and the G_1 remains are clearly Neandertal, as discussed previously. Moreover, the direct AMS dates on two of the G_1 Neandertals are significantly younger than the dates obtained from the Vindija G_3 Neandertals. Additionally, the Vi 207 mandible, as well as other specimens such as the Vi 307 zygomatic and Vi 308 supraorbital torus fragment, have the distinctive red clayey/loam sediment of level G_1 embedded in crevices and spaces in the bones, and lack the distinctly different sediments of stratigraphically adjacent layers. The Vi 3437 split-based bone point also had the same distinctive red sediment and was found directly next to Vi 207 (Radovčić, personal communication). Furthermore, the same distinctive red sediment infiltrated the Vi 3439 massive based (Mladeč) point. Of course these factors do not prove that the bone point could not be in level G_1 as the result of mixture of the layers, but it makes it less likely. It should also be noted that the F complex does not have other examples of split-based bone points. Thus, there is not an assemblage of such points from which one ended up artificially mixed into G_1.

Bruner's (2009) study of refitting shows a relatively high percentage of refit among pieces from different stratigraphic levels. She points out that refitted pieces come from levels presumably separated by another level, which would suggest particularly poor stratigraphic control. However, in many cases, levels of the G complex are not continuous in the cave, so that refitted pieces from say G_1 and G_3 may actually reflect mixing between contiguous levels. Thus, the extent of the problem is likely not as great as she suggests.

In discussing the Châtelperronian, Klein (2009) indicates that more than one or two sites with possible evidence of Neandertal–early modern human interaction are needed to rule out coincidence of other factors. Zilhão (2011) is skeptical of claims of such interaction for another reason; as explained previously, he believes all Initial Upper Paleolithic (like the Châtelperronian) is earlier than the appearance of modern humans and their cultural manifestations in Europe. Because of the problems with Vindija, we know that it will never convince skeptics, regardless of the basis for their skepticism. But we believe that there is a strong case to be made that enough evidence exists to suggest the real possibility of a culturally based interaction, to go along with the indications of biological interaction, at Vindija. However, the Vindija case also demonstrates the difficulties inherent in separating a culturally mixed circumstance from one of natural mixture and thus serves as a reminder how carefully these ephemeral manifestations must be excavated in the future.

Compared to Vindija, the Adriatic region offers little to aid in understanding the Middle-Upper Paleolithic transition, but it does offer some important insights. There is evidence that people used Mujina pećina during the autumn and spring while there is no evidence for hominin activity at this site during the summer and winter (Miracle 2005) which raises a question where these hominins lived during these periods (Karavanić et al. 2008b). They might have moved closer to the coast and one of the locations on their trail might be the Kaštel Štafilić underwater site, while other locations are most likely also below see level at present time, or destroyed by subsequent changes in sea level. Although no diagnostic fossil hominin remains have been found at Dalmatian Middle Paleolithic sites, the archaeological assemblage (Mousterian industry) and the results of chronometric dating indicate that their sequences are contemporary with the late Neandertals and earliest known anatomically modern human groups in Europe.

Sites dated to the early Upper Paleolithic are rare in this area, as well as in the whole eastern Adriatic (Karavanić 2009; Mihailović 2009), and there is a chronological gap between the late Middle and early Upper Paleolithic (see Karavanić 2009; Papagianni 2009; Papagianni and Morse 2013). Further, no industry from a single site of the eastern

Adriatic region shows a progressive or transitional nature, and there is no evidence of an *in situ* transition at any site in this region. Possible reasons for this situation are as follows: insufficient level of research, flooding or abrasion as a result of rising sea levels, and/or low population density in the eastern Adriatic during the Middle/Upper Paleolithic transition and early Upper Paleolithic (Karavanić 2009). It is also possible that Neandertal populations had disappeared from this region before the arrival of the first anatomically modern humans (see Papagianni 2009; Papagianni and Morse 2013), or Neandertals where late inhabitants of several niches in eastern Adriatic (Šošić Klindžić et al. 2014) which were avoided by early modern humans.

Although it is not clear why no site in the eastern Adriatic region thus far documents the Middle/Upper Paleolithic transition, and why early Upper Paleolithic sites are very rare, new research on Dalmatian Mousterian sites enables a better comparison with other Adriatic and continental sites. Furthermore, this new research makes a contribution towards our understanding of the distribution of Mousterian people, the complexity of the processes that underlie the interactions between Middle and Upper Paleolithic populations in the late Pleistocene of Central and SE Europe, and the reconstruction of the mobility patterns of Paleolithic populations. Therefore, it is of crucial importance to continue research that will include mapping and test excavations of both cave and open-air sites, as well as underwater research at the Kaštel Štafilić site and underwater survey for Paleolithic sites.

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