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The Middle/Upper Paleolithic interface and the relationship of Neanderthals and early modern humans in the Hrvatsko Zagorje, Croatia

This paper presents the first detailed analysis of the artefacts from the Mousterian level G3 at Vindija Cave and a revision of the artefact analysis for the early Upper Paleolithic levels (j, i) at Velika Pećina, both in Croatia. Combined with an assessment of the artefacts from the crucial G1 level at Vindija, results of these analyses are used to argue that the combination of Middle and Upper Paleolithic elements in the upper G complex at Vindija is not necessarily the result of geological mixing but may well represent a natural cultural assemblage. Some Upper Paleolithic elements are possibly derived from the local Mousterian, while others result from extraneous cultural influences into this region. Interestingly, currently available radiocarbon dates indicate that Neanderthals (Vindija level G1) and early modern humans (Velika Pećina) were penecontemporaneous in this region at ca. 33 ka, or perhaps somewhat earlier if the radiocarbon dates are taken as minimum age estimates. Therefore some Upper Paleolithic tools associated with the Vindija G1 Neandertals, such as bone points, may result from imitation of or trade with early modern people. While there is external influence on the development of the early Upper Paleolithic in this region, it exhibits a unique character which does not conform to that of classic Western or Central European Aurignacian.

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Introduction

The sites of the Hrvatsko Zagorje (northwestern Croatia) are well known in paleoanthropology because of the important finds of fossil humans and their material cultures in this region. The most significant Middle Paleolithic sites in this area are Krapina, Vindija, Velika Pećina and Veternica near Zagreb (Figure 1). The Neanderthal remains from Krapina (Gorjanović-Kramberger, 1906; Malez, 1971; Radovčić *et al.*, 1988; Smith, 1976*a*; Wolpoff, 1996) and Vindija (Malez, 1975; Malez *et al.*, 1980; Malez & Ullrich, 1982; Smith *et al.*, 1985; Smith & Ahern, 1994; Wolpoff *et al.*, 1981) have been studied from various perspectives. Also the Mousterian artefacts from Krapina (Gorjanović-Kramberger, 1913; Malez, 1970, 1978; Simek, 1991; Simek & Smith, 1997) and, to a lesser extent, Velika Pećina (Malez, 1967, 1974) have been described and analyzed.

Unlike Krapina, Vindija and Velika Pećina also contain Upper Paleolithic stratigraphic units with modern human fossil remains (Smith, 1976*b*, 1982). The Upper Paleolithic bone tools and lithics from these sites have been analyzed (Karavanić, 1994, 1995, 1996; Malez, 1967, 1974, 1978, 1988), while the Middle Paleolithic material from Vindija has been presented only in part (Malez, 1978; Karavanić, 1996). Furthermore, since Vindija and Velika Pećina have Middle and Upper Paleolithic components in association with remains of fossil humans, these two sites have the potential to make a significant contribution to both the unsolved issue of the relationship between Middle

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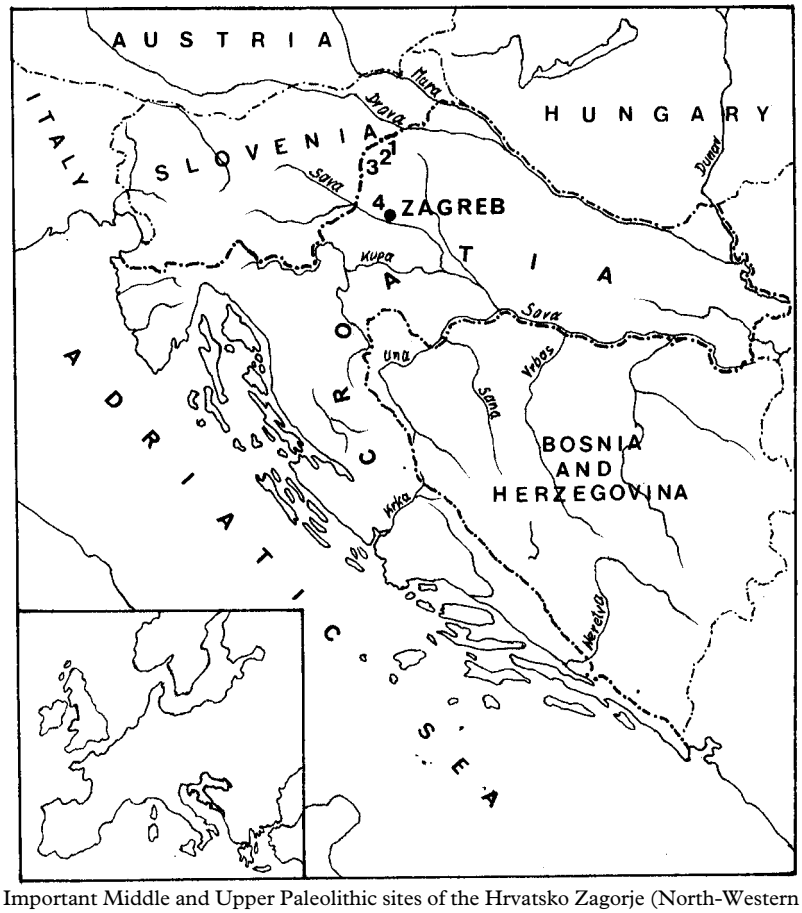

Figure 1. Important Middle and Upper Paleolithic sites of the Hrvatsko Zagorje (North-Western Croatia): 1. Vindija (Middle and Upper Paleolithic), 2. Velika Pećina (Middle and Upper Paleolithic), 3. Krapina (Middle Paleolithic), 4. Veternica (Middle Paleolithic).

and Upper Paleolithic in Central Europe (see Allsworth-Jones, 1986) and also to the debate concerning the appearance of early modern Europeans (see Stringer, 1989; Wolpoff, 1989; Smith, 1991).

Vindija Cave is one of the rare European sites with the possibility of an association between Upper Paleolithic tools and Neanderthal skeletal remains. Other such associations involve the Chatelperronian in France at the sites of Arcy-Sur-Cure and St. Césaire, but at Vindija the Upper Paleolithic assemblage is clearly not Chatelperronian and has been suggested to represent the Aurignacian (Malez *et al.*, 1980; Smith, 1982; Smith & Ahern, 1994; Karavanić, 1995).

We present the first full arachaeological description of the Mousterian level G3 at Vindija, as well as further information on the archaeological remains from level G1 and the early Upper Paleolithic levels at Velika Pećina. We also present a revisiting of the hypothesis that Neanderthals and the Upper Paleolithic are associated in Vindija, based on analysis of both the artefacts and the fossils human remains, as well as chronometric dates from the pertinent levels at Vindija and Velika Pećina. Finally, we reassess evidence pertaining to the origin of both modern human morphology and Upper Paleolithic technology in the Hrvatsko Zagorje.

The material from Vindija and Velika Pećina that is analyzed here was exacavated under the direction of M. Malez and is housed in the Institute for Paleontology and Quaternary Geology of the Croatian Academy of Sciences and Arts in Zagreb. Archaeological material from Vindija excavated by S. Vuković is not included in this analysis because of the incompatibility of his stratigraphy and that of Malez & Rukavina (1979). The stone tools were described according to the terminology of Bordes (1961) for the Middle Paleolithic tool types, even if these derive from Upper Paleolithic levels. Similarly, the terminology of Soneville-Bordes & Perrot (1953, 1954, 1955, 1956*a*, 1956*b*) is used for Upper Paleolithic tool types, even if these are associated with primarily Mousterian assemblages. This approach is taken because it provides greater precision in the description of certain tool categories. Since statistical comparison cannot be applied to these data, the benefits of greater descriptive precision are not overridden by possible problems of statistical comparison. The bone tools were classified according to Albrecht *et al.* (1972).

Background

Vindija

Vindija is a large limestone cave located 2 km west of the village of Donja Voća. The entrance overlooks the narrow gorge on the southwestern slope of Križnjakov Vrh. The cave is more than 50 m long, and its maximum width and height measure 28 m and 10 m, respectively. More than 9 m of deposits were present, and the stratigraphical profile comprises about twenty strata that Malez & Rukavina (1979) interpreted as extending from the Riss glaciation (oxygen isotope stage 6 or earlier) through the Holocene. A U–Th date on bone from level k of 114 ka suggests a last interglacial age for these deposits (Wild *et al.*, 1987/88). Level k is stratigraphically older than the G complex and basically equivalent to Mousterian deposits at Krapina, recently dated to ca. 130 ka (Rink *et al.*, 1995). Unfortunately, U–Th dates for older levels at Vindija (L & M) are inconsistent and seemingly unreliable.

Excavations were conducted in Vindija for over 30 years, beginning in 1928, by S. Vuković (1950). Vuković excavated both inside and in front of the cave, mostly in the upper levels. Subsequently, M. Malez directed excavations from 1974 until 1986. It was during this period that most of the Paleolithic archaeological and Pleistocene faunal material, as well as all of the fossil human remains, pertinent to our study were recovered. Additionally, the cave's Pleistocene stratigraphic sequence was established at this time (Malez & Rukavina, 1979).

Velika Pećina

Velika Pećina is situated near the village of Goranec on Ravna Gora, between the sites of Krapina and Vindija. The entrance is on the western slope of Plat "hill" (brdo Plat), and the cave itself is 25 m long. In some parts of the cave the sediments are over 10 m deep. There are 16 defined stratigraphic levels, ranging from the end of the Riss glaciation (oxygen isotope stage 6) through the Holocene (Malez, 1974, 1979).

Excavations in Velika Pećina were conducted initially by M. Malez in 1948, with the intention of establishing the stratigraphy and preparing for future systematic excavations. Subsequent excavations began in 1957 and, with several interruptions, lasted until 1970.

Stratigraphy and chronology

Vindija

The critical levels for assessing the relationship between the Middle and the Upper Paleolithic at Vindija are G3, G2 and G1

(Figure 2). The description of these levels used here is based on the chronostratigraphy employed by Malez & Rukavina (1979). The stratigraphically higher F complex, which is important to issues concerning the early Upper Paleolithic at Vindija, is described elsewhere (Malez & Rukavina, 1979; Karavanić, 1995).

G3 level. This level comprises a distinctive sandy green sediment, with relatively few stone fragments. Thickness of the level varies from 10 cm to 30 cm. The only currently available date for this level is an amino-acid date of 42,400 ± 4300 BP done by R. Protsch (Smith *et al.*, 1985). Unfortunately, dates by this technique must be viewed cautiously due to the well-known problems with amino-acid dating of bone.

G2 level. Made up of grayish clay sediment with abundant small stone rubble, this level is present only in some parts of the cave. Thus there are portions of the cave where G1 and G3 are in direct stratigraphic contact. Thickness of the G2 level ranged between 1 and 30 cm.

G1 level. This is a distinctive stratum, formed by a red-brown clay sediment, 8–20 cm in thickness. It is easily distinguished from other levels of the G and the overlying F complexes. Occasionally it contains carbonaceous particles. Artefacts and bone from G1 are often distinguished by adhering grains of this matrix, which is unique in the cave. Chronostratigraphically G1 correlates to the Würm 2/3 interstadial in the French version of the Alpine terminological scheme (Rukavina, 1983). Recent radiocarbon anaysis of a cave bear bone sample from this level produced an age estimate of 33,000 ± 400 BP (Karavanić, 1995).

There are still many unresolved issues relating to the stratigraphic interpretation of Vindija. The most significant of these is the occurrence of cryoturbational phenomena in the cave (Malez & Rukavina, 1975), and its role in potential mixing of elements between layers (Stringer, 1982*a*, 1982*b*; Kozłowski, 1996; Montet-White, 1996). This issue will be discussed in the context of describing the archaeological and paleontological remains from the site.

Velika Pećina

The critical levels for assessing the relationship between the Middle and Upper Paleolithic at Velika Pećina are k, j and i (Figure 2). The description of these levels used here is based on the chronostratigraphy employed by Malez (1979). It is important to note that there is no evidence of cryoturbational activity documented for Velika Pećina (Malez, 1974; Radovčić, personal communication).

k level. This is a light yellow, sandy clay stratum, with stones comprising ca. 95% of its volume. Level k measures between 160–180 cm in thickness.

j level. This layer is formed of light brown, compact clay approximately 40 cm thick.

i level. This stratum is a pale, light brown clay with a large number of stones. It ranges between 80–85 cm in thickness. Radiocarbon dating yielded an age estimate of 33,850 ± 520 BP (Malez & Vogel, 1970).

Vindija industries from levels G3, G2 and G1

Level G3

Level G3 yielded 357 pieces of knapped stone, of which 50 (14%) represent typologically defined tools. Debitage consists of 242 flakes (53 primary decortication, 60 secondary decortication), 23 cores, 24 chunks and 16 broken pebbles. One hammerstone is also present. Most of the debitage (77·9%), as well as many of the

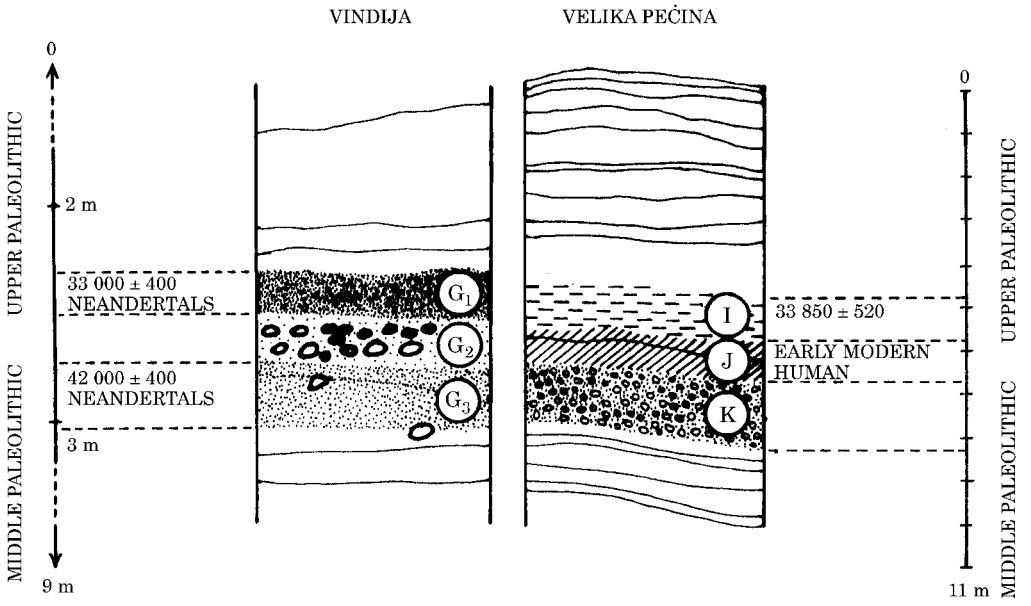

Figure 2. Potential correlation of the Vindija and Velika Pećina levels discussed in the text (after Malez, 1974; Rukavina, 1983).

Middle Paleolithic-type tools, are made of white quartz. Other Middle Paleolithic and all Upper Paleolithic-type tools are made of other raw materials (chert, tuff, etc.). Debitage is also present in G3 that matches the raw material for three of the endscrapers recovered from this level. This might be support for the production of these Upper Paleolithic type tools in level G3. Unfortunately, this is not conclusive, because some Middle Paleolithic-type tools are also made from the same raw material.

The tools from level G3 are: nine notched pieces (Figure 3, nos. 2, 5), nine denticulated pieces (Figure 3, no. 6) plus one probable pseudo-tool (Figure 3, no. 7), four single convex sidescrapers (Figure 3, no. 8), five single straight sidescrapers (one of which is in combination with an endscraper), a single concave sidescraper, four naturally backed knives (one being partially backed by retouch—Figure 4, no. 6), a double straight convex sidescraper (Figure 4, no. 5), a double concave convex sidescraper, an alternate retouched sidescraper (Figure 3, no. 3), an unfinished leaf-shaped bifacial piece (Figure 3, no. 4), three endscrapers on flakes (Figure 4, nos. 1, 2, 4), one endscraper on a core, two limaces, one raclette, a burin, a rabot, a chopping tool (Figure 4, no. 7), a blade with two continuously retouched edges (Figure 3, no. 9) and a tool in the shape of a small point. Also, there are 13 additional pieces that cannot be formally classified. They are made of white quartz and were probably used as tools. The minimum frequency of sidescrapers and limaces in the tool assemblage is 30%.

Flake technology is dominant in level G3 as would be expected in a Mousterian assemblage, but there is also evidence of blade technology (Figure 3, nos. 1, 2, 8, 9; Figure 4, no. 3) and bifacial technology (Figure 3, no. 4). Some tools were made on large blades, and one unfinished leaf-shaped bifacial piece was probably made by two unifacial treatments (A. Marks, personal communication). No use of the Levallois

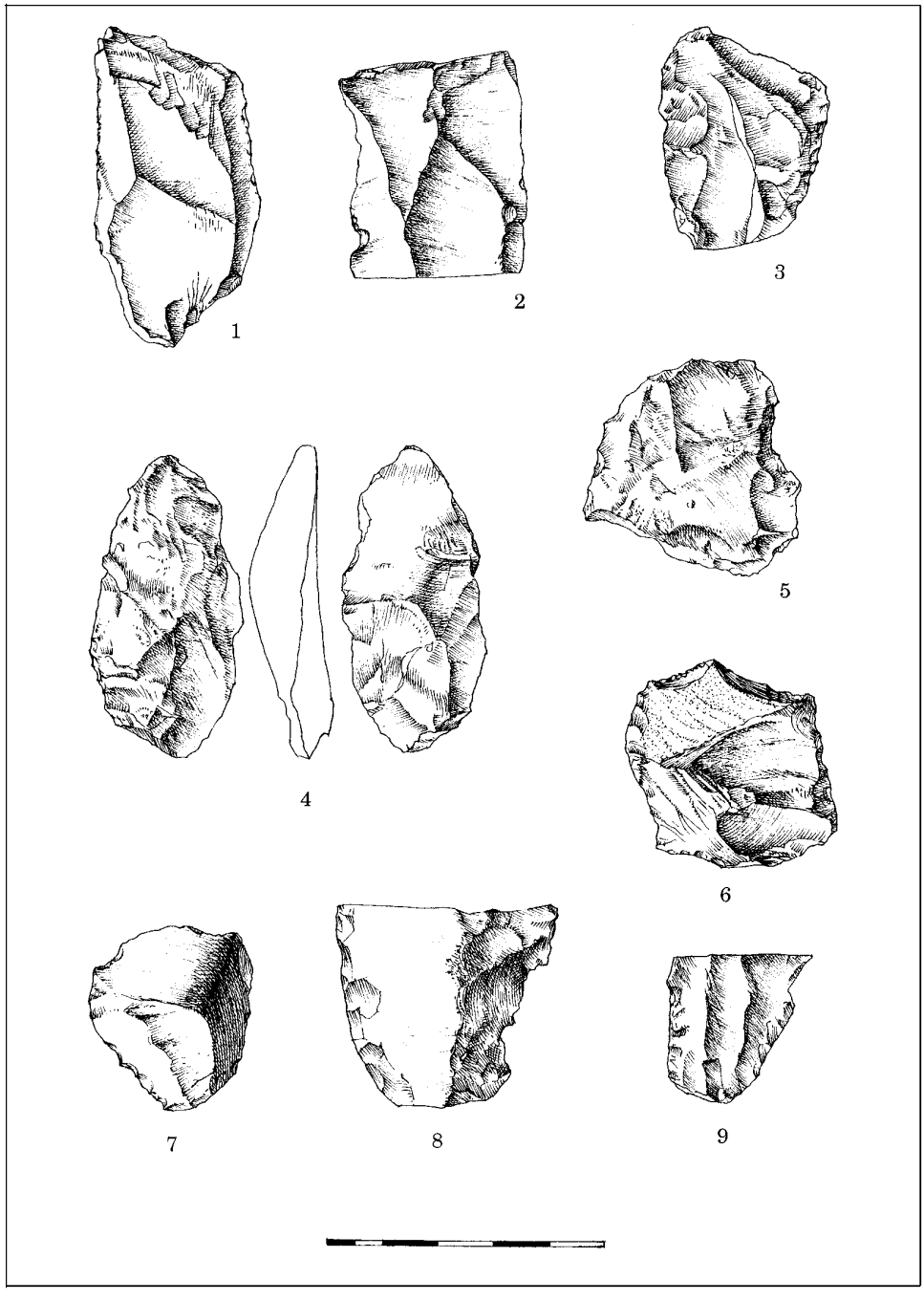

Figure 3. Selected artefacts from Level G3, Vindija Cave: 1. blade (with edge damage); 2 & 5. notched pieces; 3. alternate retouched sidescraper; 4. leaf-shaped bifacial piece (unfinished); 6. denticulated piece; 7. pseudo-tool; 8. single convex sidescraper; 9. blade with two continuously retouched edges. Scale is in cm.

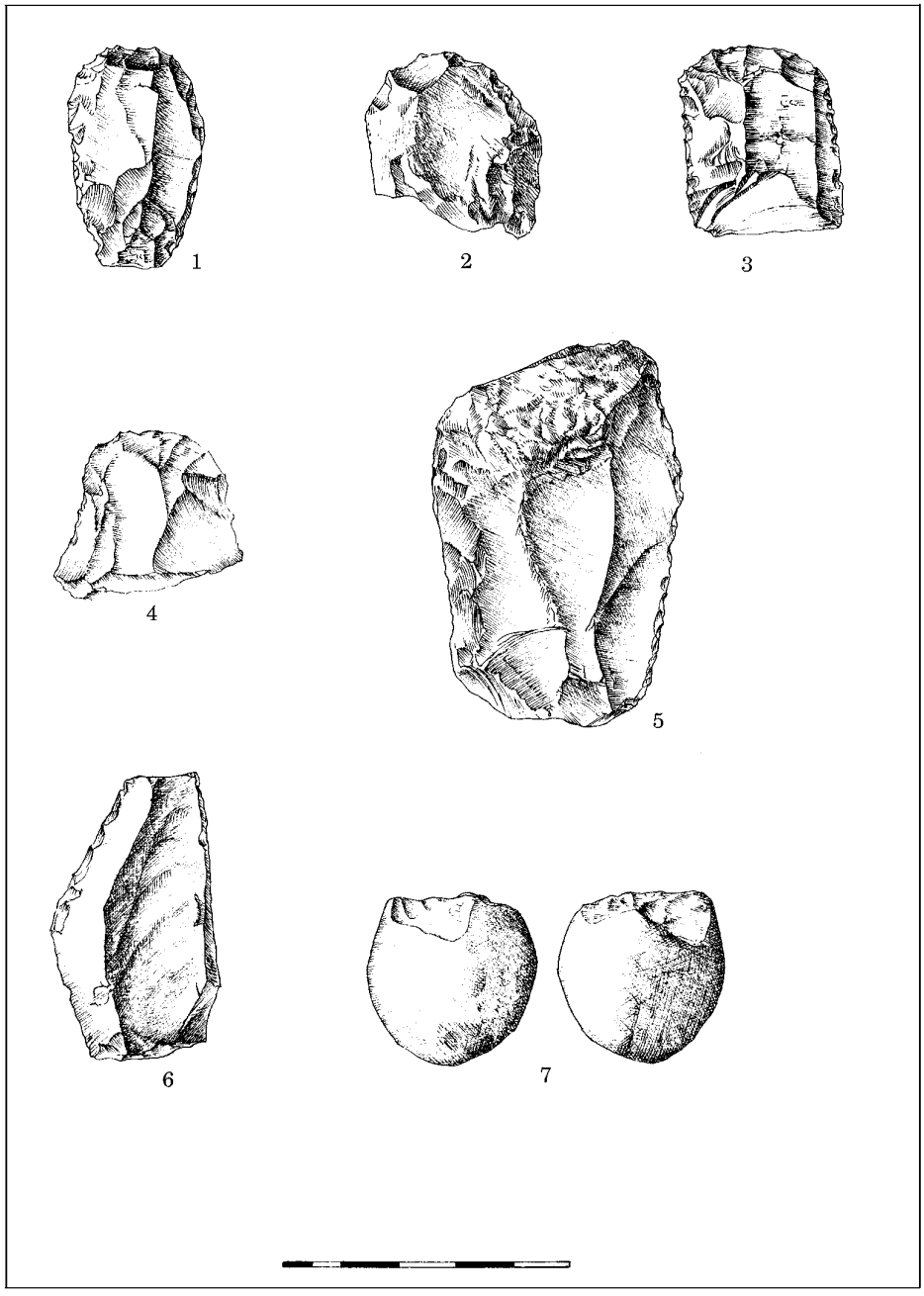

Figure 4. Selected artefacts from Level G3, Vindija Cave: 1, 2 & 4. endscrapers on flakes; 3. endscraper on (broken) blade; 5. double straight convex sidescraper; 6. naturally backed knife (partially backed by retouch); 7. chopping tool. Scale is in cm.

technique is evident in the lithics from this level. The presence of Upper Paleolithic types (such as endscrapers) is readily observable, and I. Turk (personal communication) has noted that numerous endscrapers of similar types are present in the Upper Paleolithic of Bacho Kiro in Bulgaria (see Kozłowski *et al.*, 1982).

The presence of these Upper Paleolithic tools in this Mousterian level might possibly have been caused by mechanical mixing of elements from different strata. However, none of these Upper Paleolithic tools exhibit rounded edges which would clearly demonstrate abrasion due to cryoturbation (see Laville *et al.*, 1980: Fig. 3.12). Furthermore, raw material similarities between the finished tools and the debitage lend some support to the assertion that the majority of the tools, including the Upper Paleolithic types, were produced during the time span represented by this level. Bearing all these facts in mind, an argument can be made that level G3 represents a late Mousterian industry with the co-presence of flake, blade and bifacial technology, as well as tools displaying Upper Paleolithic traits.

G2/3

Eight pieces of the lithic industry carry the G2/3 designation. These are: one large flake (probably used), one nosed endscraper (Figure 5, no. 1), two blades with two continuously retouched edges (Figure 5, nos. 2, 3), a single straight sidescraper, a single convex sidescraper, an alternate retouched sidescraper, and a scraper-drill. These tools also represent a mixture of Middle and Upper Paleolithic elements, including one Aurignacian tool (the nosed endscraper). For these tools it is impossible to establish whether they belonged to level G2 or G3.

Level G2

This level yielded nine pieces of debitage (one chunk and eight flakes—two primary decortication, four secondary decortication) and four tools. The tools are: one notched piece, a transverse convex sidescraper (Figure 5, no. 5), a sidescraper with bifacial retouch (Figure 5, no. 4), and a naturally backed knife. Level G2 is present only in some parts of the cave (Malez & Rukavina, 1979: 190), which means that the levels G1 and G3 are in contact in portions of the cave. All debitage is white quartz, but not all tools are produced from this raw material. All tools are basically Mousterian in character.

G1/G3

One hundred and thirty-five pieces of knapped stone are labelled G1/G3. Of these, 25 (18·5%) are tools. Debitage consisted of 102 flakes (including 20 primary decortication, 28 secondary decortication, two retouched), four cores and four chunks. Typical tool types are: a sidescraper retouched on the ventral surface (Figure 5, no. 7), an abrupt retouched sidescraper, an alternate retouched sidescraper (Figure 5, no. 6), a single concave sidescraper, an endscraper on a flake (Figure 5, no. 9), an endscraper on a broken blade (Figure 5, no. 10), a straight dihedral burin (Figure 5, no. 11), a drill (Figure 5, no. 12), a limace, a drill-endscraper, notches, denticulated pieces and a notched bladelet (Figure 6, no. 6). For these tools it is impossible to establish whether they belonged to level G1, G3 or, in some cases, G2. One flat pebble was also found. It had edges sharpened from use (scraping-polishing). It should be mentioned that a single artefact appears to be marked as G1/G4, but we are unaware of any contact between these layers. This is a notched piece on a fragment of blade (Figure 5, no. 8). Thus, G1/G3 marked tools are fundamentally Mousterian in character with only a few Upper Paleolithic elements.

G/g

The designation G/g (meaning G/up) refers to upper levels of the G complex. It was

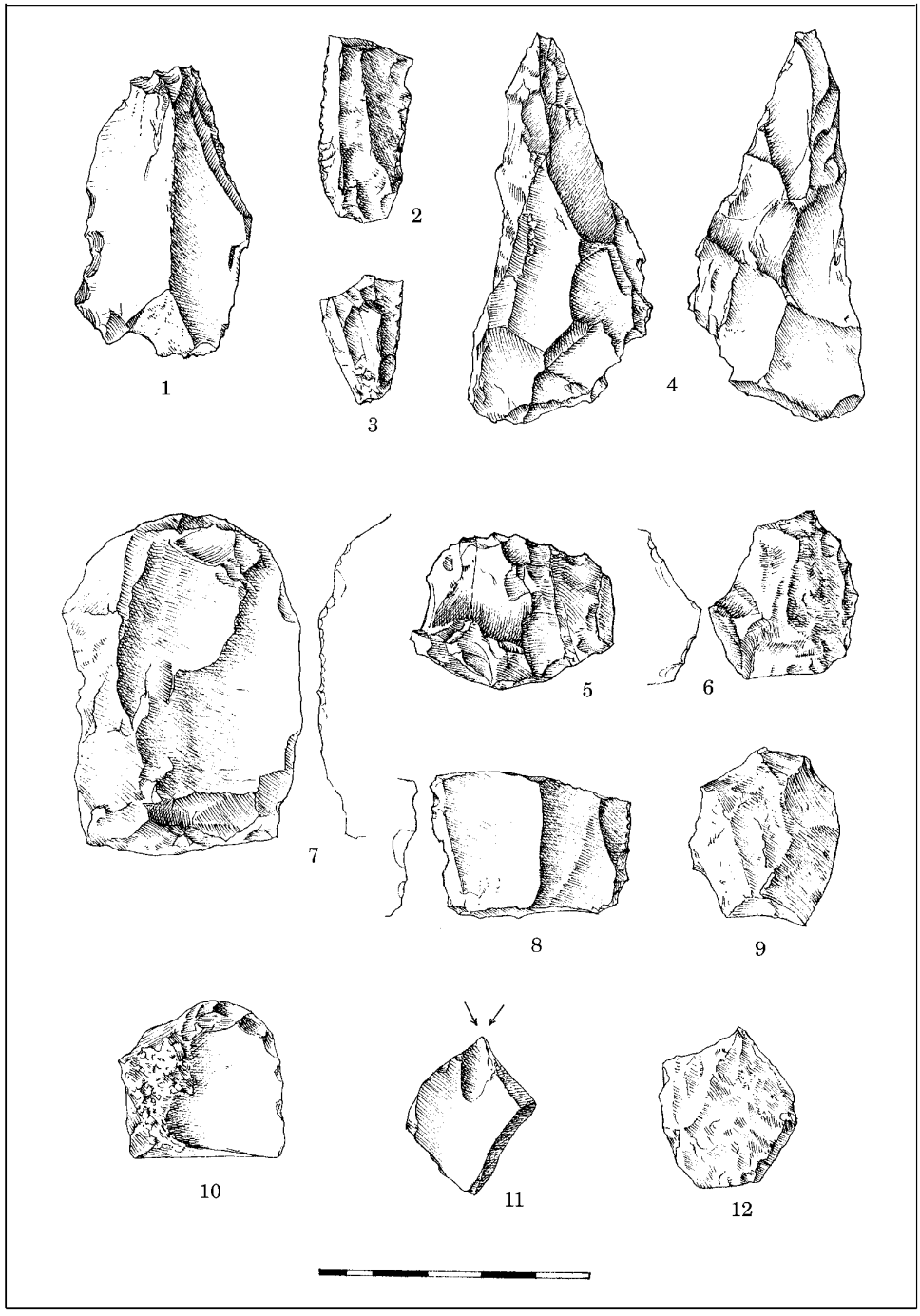

Figure 5. Selected artefacts from Vindija Cave. G2/3: 1. nosed endscraper, 2 & 3. blades with two continuously retouched edges; Level G2: 4. sidescraper with bifacial retouch, 5. transverse convex sidescraper; G1/G3: 6. alternate retouched sidescraper, 7. sidescraper on the ventral surface, 9. endscraper on flake, 10. endscraper on (broken) blade, 11. straight dihedral burin, 12. drill; G1/G4: 8. notched piece. Scale is in cm.

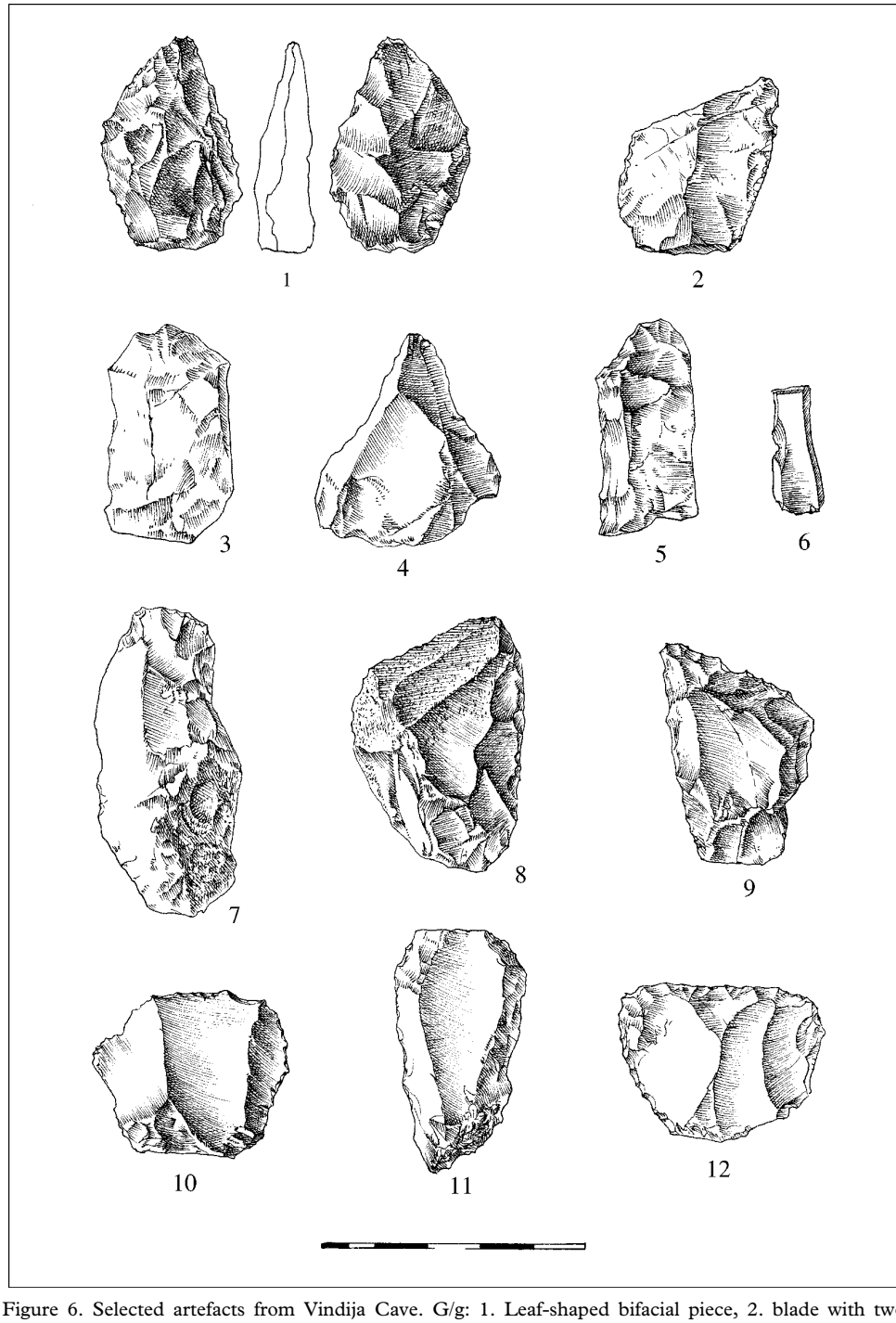

Figure 6. Selected artefacts from Vindija Cave. G/g: 1. Leaf-shaped bifacial piece, 2. blade with two continuously retouched edges, 3. endscraper on flake, 4. nosed endscraper, 5. sidescraper-endscraper, 7. nosed endscraper, 8 & 11. single straight sidescrapers, 9 & 12. offset sidescrapers, 10. denticulated piece; G1/G3: 6. notched bladelet. Scale is in cm.

probably used at the beginning of the excavation when it was not yet possible to distinguish the individual levels of the complex clearly. The G/g label is found on 43 pieces of debitage and on 34 tools. Among the debitage items, we can identify 39 flakes (including eight primary decortication, eight secondary decortication), three chunks and one blade. The most typical tool types are a leaf-shaped bifacial piece (Figure 6, no. 1), a blade with two continuously retouched edges (Figure 6, no. 2), an endscraper on a flake (Figure 6, no. 3), nosed endscrapers (Figure 6, nos. 4, 7), a sidescraper-endscraper (Figure 6, no. 5), single straight sidescrapers (Figure 6, nos. 8, 11), single convex sidescrapers, a convex transverse sidescraper, a straight transverse sidescraper, a concave transverse sidescraper, offset sidescrapers (Figure 6, nos. 9, 12), naturally backed knives, denticulated pieces (Figure 6, no. 10) and notches. These tools also represent Mousterian types together with some Upper Paleolithic types. The two nosed endscrapers are specifically Aurignacian type tools. In addition to these pieces, it is possible that some of the flakes included in the debitage represent *de facto* tools (expedient sidescrapers, notches, denticulated pieces).

Level G1

This level contains 62 chipped stone items, of which 15 (24·2%) are typologically recognizable tools. Among the debitage, 28 flakes (five primary decortation, ten secondary decortation), one core, ten chunks, and two broken pebbles can be identified. A hammerstone and complete pebble were also found. The Upper Paleolithic tool types are: an endscraper on a flake (Figure 7, no. 3), and endscraper on an Aurignacian blade (Figure 7, no. 4), a straight dihedral burin (Figure 7, no. 2) and a blade with two continuously retouched edges (Figure 7, no. 11). Five sidescrapers (Figure 7, nos. 5, 6, 7) and four denticulated pieces (Figure 7, nos. 8, 9, 10) are more typical of the Mousterian tradition. However, it is possible that some pieces classified as denticulate pieces are in fact pseudo-tools. One of these is illustrated in Figure 7 (no. 8). A leaf-shaped bifacial point, nicely retouched on both sides (Figure 7, no. 1), and a rabot also originate from this level. As in level G3, the Levallois technique was not used in level G1.

Associated with this stone industry are bone tools of types generally characteristic of the Upper Paleolithic. Especially interesting is a split-base bone point (Figure 8, no. 1) and three massive-base (Mladeč) bone points (Figure 8, nos. 2, 8, 9). There are also five other tool fragments, four of which are presented in Figure 8 (nos. 3, 5, 6, 10). Also, a bear baculum with engraved circumferential markings (Figure 8, no. 7), and a so-called ''bone button'' (Figure 8, no. 4) are designated as deriving from this level. The latter was probably produced by cave bear activity or another natural process and not by humans (see Turk, 1988). On the other hand, the bear baculum is clearly the result of human modification. Although it has been attributed to level G1 (Malez, 1988), a note associated with this specimen suggests that it may in reality have come from the upper part of G3, which would make it even older.

While the bone tools suggest an attribution of this level to the Aurignacian, the lithic industry is more equivocal. It contains typological elements typical of both the Middle and Upper Paleolithic, but only one endscraper on an Aurignacian blade is unequivocally characteristic of the Aurignacian. However, Kozłowski (1996) ascribes the G1 lithics to a ''Mousteroid-Levalloisian'' assemblage and states that ''both the dated cave bear bone and the two Aurignacian bone points are in all likelihood an admixture in layer G1 from the materials resting on the 'interface of layers G/F', the layers which represent the *typical*

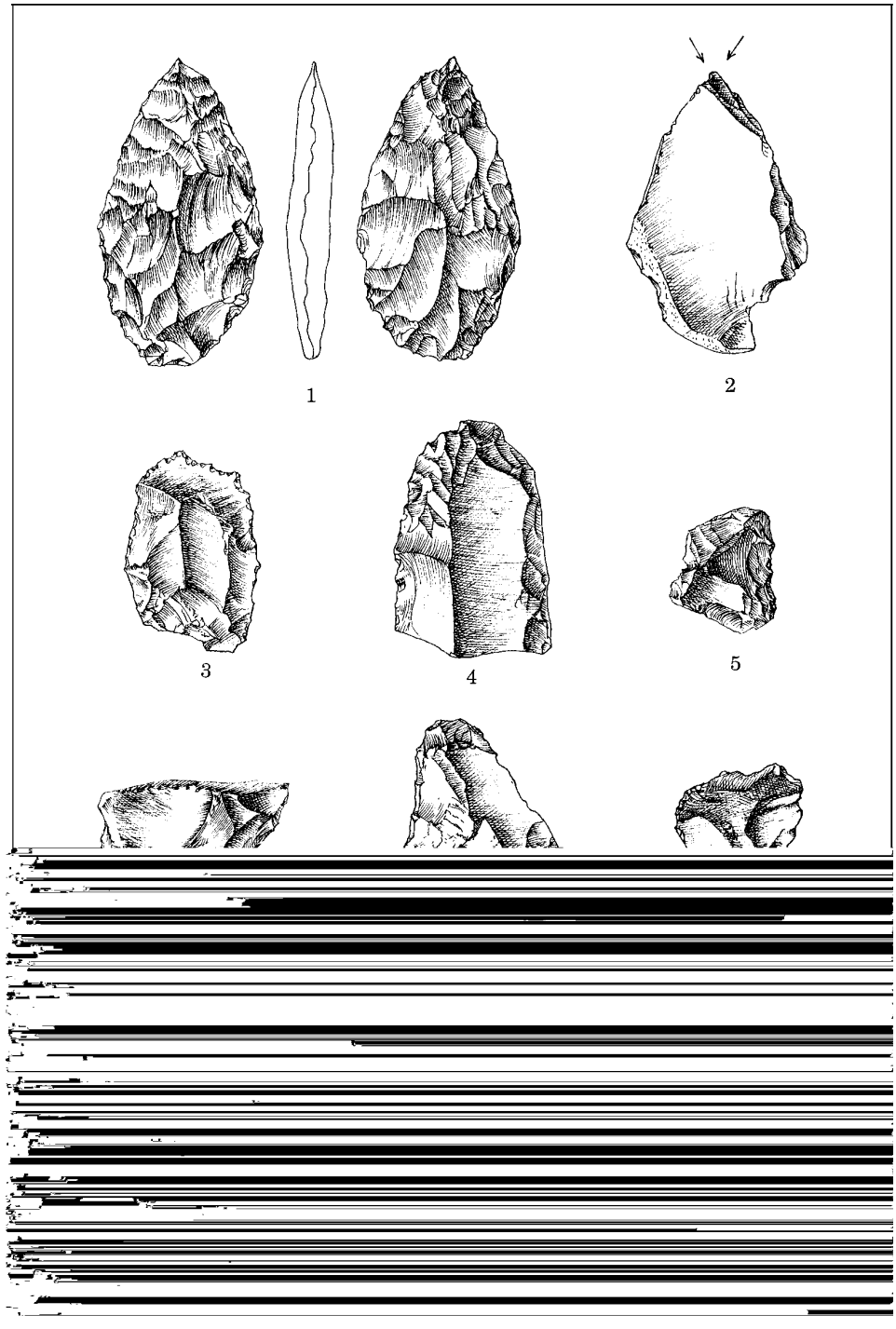

Figure 7. Selected artefacts from Level G1, Vindija Cave: 1. leaf-shaped bifacial piece; 2. straight dihedral burin; 3. endscraper on flake; 4. endscraper on an Aurignacian blade; 5. single concave sidescraper; 6. double convex sidescraper; 7. single straight sidescraper; 8, 9 & 10. denticulated pieces; 11. blade with two continuously retouched edges. Scale is in cm.

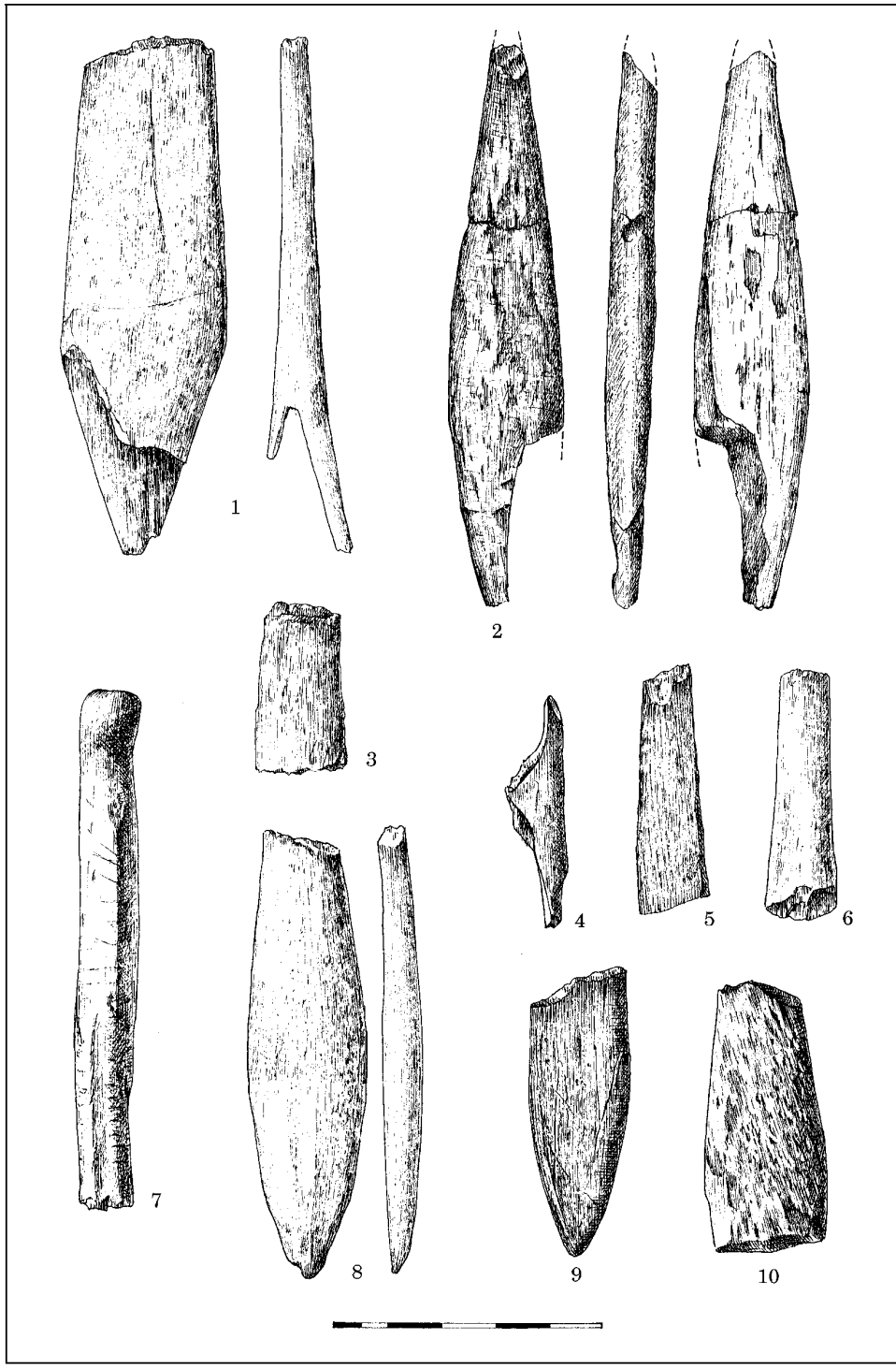

Figure 8. Bone assemblage from Level G1, Vindija Cave: 1. split-base point; 2, 8 & 9. massive-base points; 3, 5, 6, & 10. fragments; 4. "bone-button"; 7. bear baculum bone with carved circular markings (possibly from G3). Scale is in cm.

Aurignacian with blade tools and bone points'' (p. 211: emphasis ours). The proposed ''mixture solution'' (Stringer, 1982*a*, *b*; Kozłowski, 1996; Montet-White, 1996) could be possible, because in the original documentation of the excavations we found that a few stone tools from level G1 came from the areas in the cave disturbed by cryoturbation. However, as was the case in level G3, we did *not* note any modification of the Upper Paleolithic type lithic tools (e.g., nibbled, rounded edges) which would suggest mixing by this process. Furthermore, there are actually three virtually complete bone tools and several fragments from level G1 all of which would have to be attributed to mixing. As was the case with the lithic items, the bone tools lack the abrasion and battering expected if they were disturbed significantly by cryoturbation.

Unfortunately, excavation records do not identify the precise grid location for most of the bone tools. However, the split-base bone point and virtually all of the human fossil remains, including the Vindija 207 mandible (Figure 11), were excavated north of profile II as presented in Malez & Rukavina (1975). The strata from this portion of the cave do not exhibit any obvious evidence of cryoturbational activity, as the photographs, published profiles, and descriptions from this part of the cave demonstrate. The part of the cave showing extensive cryoturbation is located approximately 2 m south of Malez and Rukavina's profile II. Thus, while some mixing may have occurred, it is difficult to attribute all of the archaeological characteristics of the Vindija G1 level to the effects of cryoturbation.

Velika Pećina industries from levels k, j and i

Level k

Level k is divided into seven zones (k1–k7). The lower part of the level (zones k7, k6 and the lower part of k5) produced only five tools, one flake and a piece of a quartz pebble (Malez, 1967: 22–25). Recent reanalyses of these specimens revealed tools belonging to the following types: one Levallois point (Figure 9, no. 1), two alternate retouched sidescrapers (Figure 9, nos. 3, 5), and two denticulated pieces (Figure 9, nos. 2, 4). In the upper part of zone k5, and zones k4 and k3, there were no artefacts; and only three tools have been found in zones k2 and k1 (Malez, 1967: 26). These are: one probable notched piece (Figure 9, no. 7) and two pseudo-tools (Figure 9, nos. 8, 9). One so called ''bone button'' (Figure 9, no. 6) was found in zone k1, but, as previously noted, these are not human-made artefacts (see Turk, 1988).

Malez (1967: 28) attributed the artefacts from the lower part of level k to the Mousterian and those from the upper part tentatively to the proto-Aurignacian, because they were not typical of any defined industry. He suggested that they could also belong to the Mousterian. Considering the small quantity and typological characteristics of the tools from level k, there is no convincing reason to recognize two different industries. It is likely that the lower part of level k belongs to the Mousterian, and the upper part may contain only pseudo-tools (geofacts).

Level j

Only one stone tool originates from this level, a blade with two continuously retouched edges with a notch on the left side (Figure 10, no. 1). Because it was impossible to determine a distinct industry affiliation, and because the next higher level was thought to represent the Aurignacian, Malez (1967: 28) used the term proto-Aurignacian for the single tool in level j. A human frontal fragment (Smith, 1976*b*) derives from this level.

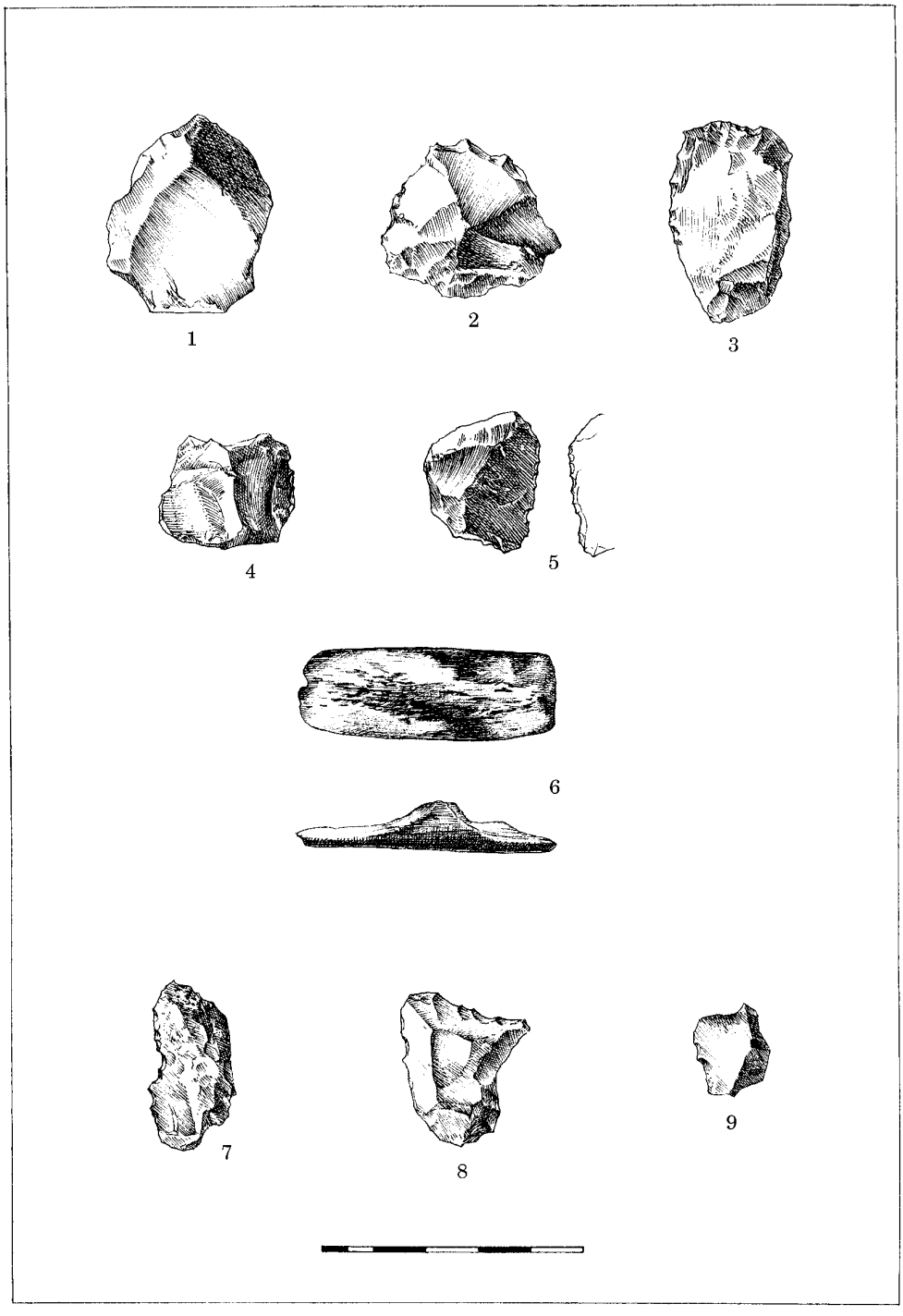

Figure 9. Selected artefacts from Velika Pećina. Level k (zones k7, k6, k5): 1. Levallois point, 2 & 4. denticulated pieces, 3 & 5. alternate retouched sidescrapers; Level k (zones k2 and k1): 6. "bone-button", 7. notched piece, 8 & 9. pseudo-tools. Scale is in cm.

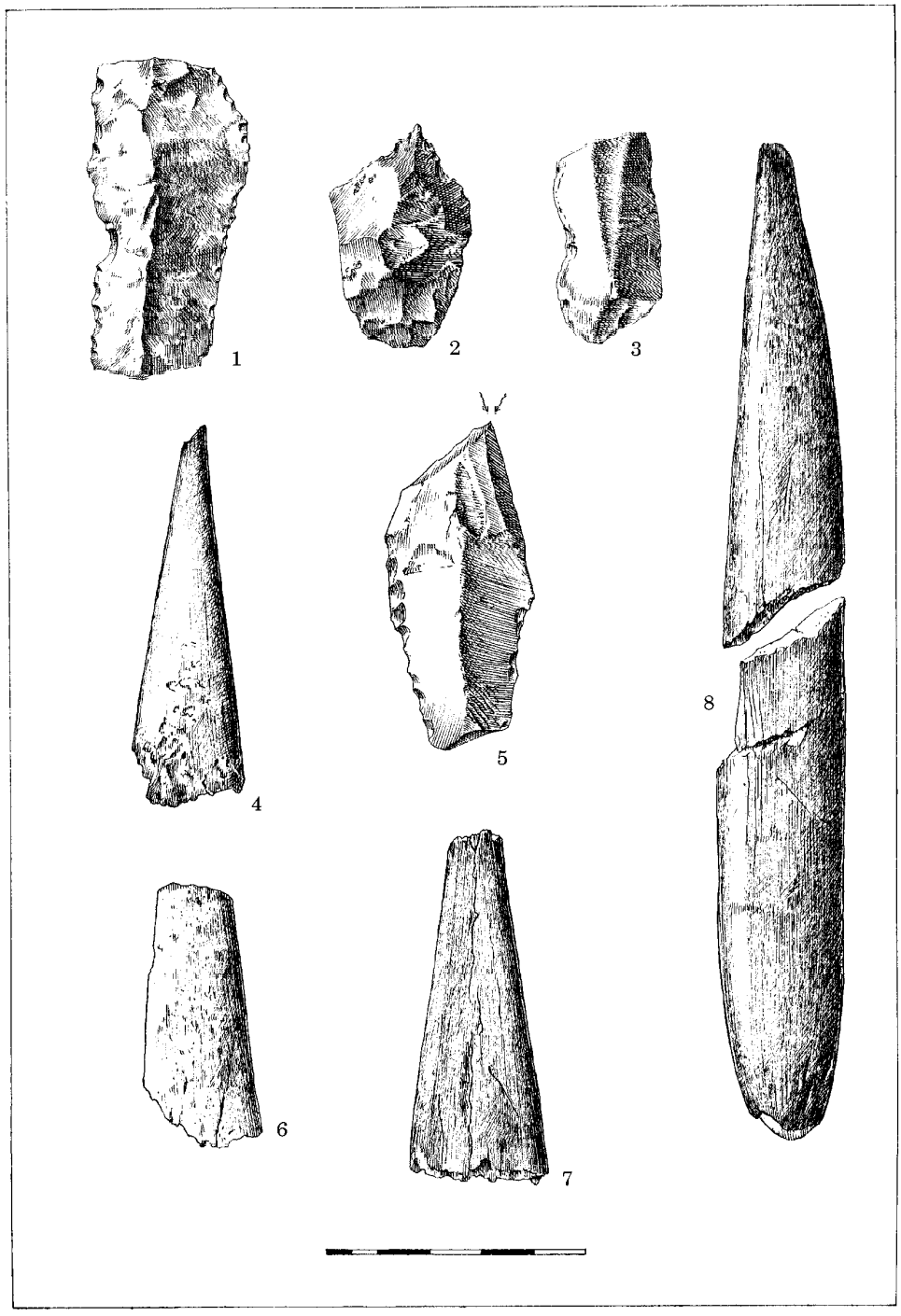

Figure 10. Selected artefacts from Velika Pećina. Level j: 1. blade with two continuously retouched edges (with notch on left side); Level i: 2. drill, 3. endscraper on (broken) blade with a notch, 5. canted dihedral burin, 4, 6 & 7. bone points (probably split-base), 8. massive-base bone point. Scale is in cm.

Level i

Seven stone and three bone artefacts were found in level i. The stone tools are: one canted dihedral burin (Figure 10, no. 5), a drill (Figure 10, no. 2), double convex sidescraper, convergent convex sidescraper, alternate retouch sidescraper and end-scraper on (broken) blade with a notch (Figure 10, no. 3). There is also one bladelet core. Bone tools consist of three points that probably had split bases (Figure 10, nos. 4, 6, 7) and one massive-base (Mladeč) point (Figure 10, no. 8). Originally Malez (1967) attributed the base of this Mladeč point to level h, but it fits with a point tip from level i.

While the stone artefacts include some Upper Paleolithic types, Middle Paleolithic types (three sidescrapers) are also represented. However, the bone points strongly suggest an Upper Paleolithic affiliation. The precise determination of which Upper Paleolithic industry is represented is more difficult because of the lack of typical stone tools. Mixture of Upper and Middle Paleolithic type tools at Velika Pećina cannot result from the effects of cryoturbation, because there is no evidence of this process reported in this cave (Malez, 1967, 1974; Radovčić, personal communication).

Human remains

Fossil human remains from the Hrvatsko Zagorje are known from the sites of Krapina, Vindija, and Velika Pećina and have been discussed in several recent assessments of late Pleistocene human evolution (Malez, 1978; Smith, 1982, 1984, 1991, 1994; Wolpoff, 1980, 1996). These remains are divisible into three groups: Neanderthals (Krapina and Vindija levels G3 and G1), early modern Europeans (Velika Pećina and Vindija levels Fd and Fd/d), and later Upper Paleolithic-associated specimens (Vindija level D). The most pertinent of these to the issues under consideration here are Velika Pećina and the Vindija G1 and F complex samples.

The human remains from Vindija level G3 unquestionably represent Neanderthals (Wolpoff *et al.*, 1981; Smith *et al.*, 1985), albeit with a distinct pattern of changes in facial morphology compared to earlier Neanderthals. Among such changes are vertical mandibular symphyses, mandibles with an incipient *mentum osseum* and *incurvatio mandibulae*, maxillae with narrower nasal apertures and shorter alveolar processes, and supraorbital tori with a shape somewhat intermediate between the Krapina Neanderthals and early modern Europeans (Smith, 1994; Wolpoff, 1996).

The human remains from Vindija level G1, are fragmentary and not extensive (Table 1), but they clearly represent Neanderthals. This assessment is based on the presence of a true supraorbital torus on Vi 308, the morphology of the Vi 307 zygomatic, the large size and shoveling pattern on the Vi 290 incisor, and the retromolar space and horizontal-oval mandibular foramen on Vi 207 (Figure 11) (Smith, 1984; Smith & Ahern, 1994; Wolpoff *et al.*, 1981).

Many of these features are not unique to Neanderthals. Retromolar spaces (Franciscus & Trinkaus, 1995) and columnar frontal processes on the zygomatic (Smith, 1976*a*; Smith & Ahern, 1994) occur, but are rare, in post-Neanderthal Europeans. Features like multiple zygomaticofacial foramina, well-developed Breschet's sulci, horizontal-oval mandibular foramina, and maxillary incisor shoveling, all of which characterize the Vindija G1 remains, occur in varying frequencies in Upper Paleolithic-associated remains, but are still more common in Neanderthals (e.g. Smith, 1978; Frayer, 1992; Wolpoff, 1996). Despite some uncertainty about individual features, the complex of features exhibited by the six G1 specimens from Vindija, taken collectively, would be extremely

Table 1 Vindija human skeletal remains from levels G_1, Fd, and Fd/d (original descriptions in Wolpoff *et al.*, 1981, Smith *et al.*, 1985)

Specimen	Level	Description	Salient features
Vi 207	G_1	Right mandibular ramus with edentulous posterior corpus	(1) retromolar space[b] (2) horizontal-oval mandibular foramen[b]
Vi 208	G_1	Anterior, superior fragment of left parietal	(1) Breschet's sulcus well-developed[b]
Vi 287	G_1	Right upper canine	—
Vi 290	G_1	Right upper central incisor	(1) strongly shovel-shaped[b] (2) large size[b]
Vi 307	G_1	Left zygomatic bone	(1) columnar frontal process[b] (2) multiple zygomaticofacial foramina[b]
Vi 308	G_1	Left frontal fragment with medial supraorbital torus	(1) true supraorbital torus (2) large frontal sinus, restricted to torus
Vi 204	Fd/d[a]	Right posterior parietal; articulates with Vi 302 (left posterior parietal)	(1) gabled coronal contour (2) slight lambdoidal flattening
Vi 286	Fd	Lower right lateral incisor	—
Vi 289	Fd	Upper right lateral incisor	(1) strongly shovel-shaped[b]

Note: [a]Located at the interface of Fd and Fd/d. [b]Generally associated with, but not unique to, Neandertal morphological pattern.

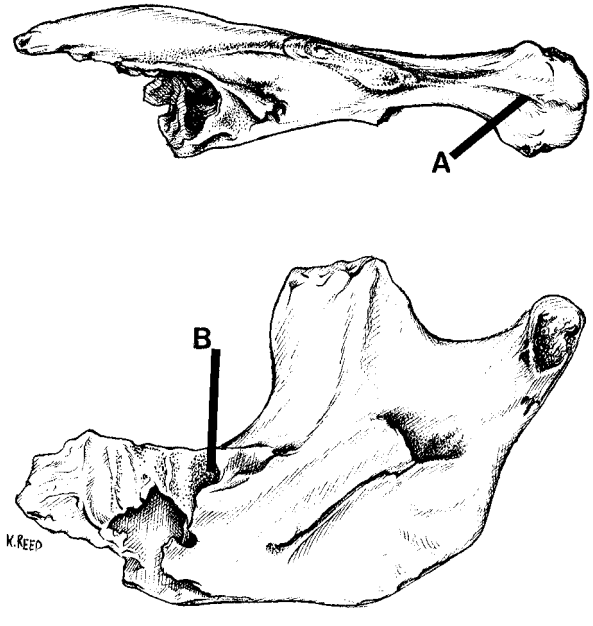

Figure 11. The Vindija 207 mandible viewed from above (top) and medially. Note the retromolar space between the alveolus for M3 (B) and the anterior border of the ramus, the horizontal-oval mandibular foramen and the rather medial position of the intersection between the mandibular notch (incisura) and the condyle (A).

Figure 12. The human frontal bone from level j at Velika Pećina. Note the distinct separation of the brow ridges into a superciliary arch and supraorbital trigone.

hard to accommodate in anything but a Neanderthal sample.

Only four specimens of early modern humans are known from the Hrvatsko Zagorje. These are the partial frontal from level j at Velika Pećina (Smith, 1976*b*), the articulated posterior parietals (Vi 204 and 302) from Vindija complex F (Smith & Ahern, 1994), and two isolated teeth from the F complex (Wolpoff *et al.*, 1981). The Velika Pećina frontal (Figure 12) is unquestionably modern in morphology, with a brow ridge clearly divided into a distinct superciliary arch and supraorbital trigone (Smith, 1976*b*). Similarly, the F complex parietals from Vindija exhibit a gabled coronal contour that conforms to the condition seen in other early modern Europeans. The incisors from the F complex could be accommodated in either a Neanderthal or early modern sample.

Although the Vindija Neanderthals exhibit systematic morphological changes toward the modern European condition (when compared to earlier Neanderthals), there is a distinct gap in cranial, though perhaps not in dental, morphology between them and the early modern remains from Velika Pećina and the Vindija F complex. Both the Velika Pećina frontal and the Vindija F parietals would not fit morphologically into the Vindija G Neanderthal samples, although in their brow ridge and lambdoidal flattening patterns they may exhibit Neanderthal-reminiscent features (Smith, 1984; Smith & Ranyard, 1980; Smith *et al.*, 1985).

Assuming the accuracy of currently available dates, both early modern humans and late Neanderthals appear to inhabit the Hrvatsko Zagorje at about 33 ka, or perhaps earlier if the radiocarbon dates are taken as minimal age estimates. If these populations are indeed penecontemporaneous, it seems unlikely that early modern people could have appeared in this region without a substantial increase in gene flow, including population movements, into Europe at this time (Trinkaus & Smith, 1985; Smith & Trinkaus, 1991).

Overview of the Middle–Upper Paleolithic interface in north-western Croatia

Typological analysis of the stone tools from Vindija level G3 indicates the presence of characteristic Upper Paleolithic type tools in a fundamentally Mousterian assemblage. In addition to typical Mousterian tools (e.g., sidescrapers) and flake technology, level G3 lithics also include evidence of bifacial technology (see Figure 3, no. 4) as well as blade technology (see Figure 3, nos. 1, 2, 8, 9). Blade technology and some Upper Paleolithic tool types can be present in the Mousterian (see Bordes, 1961); however, the Vindija G3 endscrapers (see Figure 4, nos. 1, 2, 3, 4) are smaller and less crudely made than is common in the Mousterian. The raw material comprising the debitage from level G3 suggests, but does not prove, that almost all tools *could* have been made *in situ* by the Neanderthals. Furthermore, the types of stone (white quartz, chert, tuff, sandstone) used for tool production in Vindija level G3 derive from environs near the cave, and no item suggests any other source for raw material (see Kurtanjek & Marci, 1990).

As in level G3, mixture of Middle and Upper Paleolithic typological and technological characteristics is also present in the tools from the level G1 (see Figure 7). Furthermore, the connection between G3 and G1 is also suggested by the presence of leaf-shaped bifacial pieces, which may represent a typological and technological connection between the Middle and the Upper Paleolithic in Central Europe (see Valoch, 1968; Allsworth-Jones, 1986). These tools at Vindija are found in levels G3 (Figure 3, no. 4), and G1 (Figure 7, no. 1). An additional specimen is marked as "G/g" (Figure 6, no. 1), meaning that it comes from some level in the upper G complex; and yet another one carries the marking "G/d", indicating an origin in the lower G complex (probably level G4 or G5). Malez (1979: Fig. 31, no. 6) described a fifth leaf-shaped bifacial piece from the upper strata of the complex G. Unfortunately this specimen cannot be located.

One of these specimens, from level G1, is a particularly well-made piece, fashioned of red radiolarite. It differs from the other leaf-shaped bifacial pieces from the lower levels, which are more crudely produced on black chert. The G1 point (Figure 7, no. 1) shows great similarity, both in terms of typology and color, to finds from Jankovich Cave (Hungary). There is no debitage (small bifacial thinning flakes) from Vindija level G1 reflecting production of this piece, and it is possible that this point was imported (Montet-White, 1996). However, because systematic dry and water screening were applied on only a very limited part of the sediment, it is possible that small pieces of debitage from such relatively rare raw material would not have been recovered.

Except for the possibility the bear baculum derives from G3 rather than G1 and a worked rib fragment of unknown provenience within this complex, the bone industry from the G complex at Vindija was recovered entirely from level G1. Massive-base bone points are found both in G1 and the F complex, raising the possibility that they are intrusive into G1 (e.g., Kozłowski, 1996). The single split-base bone point from G1 is the only such point recovered from the site. Absence of mechanical alteration on the tools usually associated with the effects of cryoturbation is a logical argument against extensive mixing of artefacts by geological processes at Vindija.

If the radiocarbon dates are correct, Vindija level G1 and Velika Pećina level i are penecontemporaneous at around 33 ka. Archaeologically, these two levels are similar in that both contain bone points. The lithic industry in the Velika Pećina level is meager (six tools), but does include a burin, drill and endscraper on a broken blade that are

typically associated with Upper Paleolithic industries. The Vindija G1 lithic industry is more extensive and also contains distinctly Upper Paleolithic type tools. But in neither site do the industries from these levels, nor the F complex levels at Vindija, exhibit the artefact profile typical of Aurignacian in the classic western European sense. Thus, it can be argued that we find both Neanderthals (Vindija level G1) and early modern humans associated with similar archaeological manifestations at roughly the same time in the Hrvatsko Zagorje. However, it is not prudent to consider these manifestations to represent the Aurignacian in any pan-European sense (Miracle, 1997).

Because this situation is unusual, if not unique, in Europe, the general tendency has been to consider these associations at Vindija to be the result of mixing through cryoturbation. We have noted that there are factors that do not support this interpretation. Chief among these are the absence of evidence for mechanical alteration on the pertinent stone and bone tools and the fact that a significant amount of material comes from portions of the cave not obviously altered by this process. Furthermore, several G1 human specimens and artefacts exhibit traces of the distinctive reddish matrix characteristic of this level rather than the matrix of the lower G complex or the stratigraphically higher F complex. We certainly do not claim that these factors prove absence of mixing. On the other hand, we feel that this evidence is at least as strong as the evidence favoring the mixing explanation. With this in mind, alternative explanations to mixing need to be explored.

If we exclude the mixing by cryoturbation interpretation, there are four possibilities to explain the Vindija G1 bone industry: (1) bone points were produced by early modern humans and were obtained in some way by (or found in association with) Neanderthals; (2) Neanderthals adopted the technology of making Upper Paleolithic bone points from contemporary early modern humans; (3) early modern humans adopted the technology of making bone points from Neanderthals; and (4) both groups developed the technology of making bone points. The third and fourth possibilities are perhaps the least likely, because most Neanderthal sites yield no evidence of bone technology. However, there are a few other Mousterian sites that exhibit some evidence of bone point production. These are from the late Mousterian at the German sites of Weinberghölen, Grosse Grotte, and Vogelherd (Hahn, 1988). Since the origins of Upper Paleolithic bone technology are not clearly known, the possibility that this technology developed during the Mousterian should not be categorically excluded. Indeed, Montet-White (1996) has suggested that massive-base and split-base bone points represent an adaptation to highland hunting in the regions around the Alps and Carpathians, beginning not with the Upper Paleolithic, but with the late Mousterian. Furthermore, the recently described wooden spears from Schöningen (Thieme, 1997) along with a lance from Lehringen (Thieme & Veil, 1985), both in Germany, demonstrate that pre-modern Europeans were capable of producing sophisticated tools from raw materials other than stone.

It is difficult to distinguish between the first two possibilities in an archaeological context. At Arcy-sur-Cure (France), Hublin *et al.* (1996: 226) explain the possession of Chatelperronian industries by Neanderthals as a ''. . . high degree of acculturation'', but attribute items of personal adornment to trade rather than imitation of technology by Neanderthals. The functional usefulness of the Vindija split-base point might be questionable, because the basal flanges are fragile and the overall dimensions (31·1 × 5·6 mm) suggest a structurally weak point. This could be support for the imitation explanation (C. Roubet, personal

communication). Either possibility, trade or imitation, indicates a rather complex pattern of interaction between late Neanderthal and early modern human populations in the Hrvatsko Zagorje.

The question of industry

Another issue of importance concerns the classification of these industries at Vindija and Velika Pećina. For Kozłowski (1996: 211), the stone tools from Vindija level G1 represent ''a Moustero-Levalloisian assemblage'' and the bone tools have affinities with the Aurignacian. Thus for him, G1 must be mixed. Recently, Miracle (1997; Miracle & Crummett, 1995) has demonstrated that the lithic tool assemblage from Vindija levels G1 to Fd is significantly different from the typical pattern of the French, and even from the Central European Aurignacian and is more similar to Szeletian. Furthermore, he thinks that the split-base point cannot be used as a type fossil for Aurignacian in Central Europe, because such points also occur with the Szeletian (Szeleta Cave Level 4, Dzeravá Skála Level 5-11) and in non-Aurignacian lithic assemblages in Istállóskö layers 9 to 7.

At Vindija, several Upper Paleolithic type tools derive from level G1, but only one of these (and three others from the upper G complex) might be considered definitively Aurignacian. There are also a few others from the lower F complex and from its interface with level G1. The F complex contains remains of early modern humans, so perhaps this represents an intrusive cultural entity into this region which has some affinity with the Aurignacian in a broad sense. In this case perhaps the lack of more typical Aurignacian stone tools at Vindija is the result of relatively poor-quality raw materials, the different technological experiences of the Vindija population, or some type of functional specialization (cf. Hahn, 1977).

There is another possibility that warrants consideration. At Velika Pećina, as well as the Slovenian sites of Mokriška Jama and Divje Babe I (Turk & Kavur, 1997), bone tools like those in Vindija are found with a small number of stone artefacts that are not especially typical for any particular industry, including the Aurignacian. In Potočka Zijalka (Brodar & Brodar, 1983), another Slovenian site, many stone tools show characteristics of the Mousterian, but blades and Aurignacian retouch are also frequent (Brodar & Osole, 1979). This lithic assemblage is associated with several bone tools that are very similar to those from the Croatian sites. The industry from Potočka Zijalka was at first called Olschewian by Bayer (1929). After this designation was abandoned, the industry was included in Aurignacian (Brodar, 1971). More recently, Brodar and Osole (1979) have proposed that the old name should be restored, not in the exact sense that Bayer used it, but rather as a regional cultural term for what has generally been called Central European Aurignacian. Recently this term also was used by Montet-White (1996) to designate cultural manifestations around the Alps and Carpathians characterized by the presence of bone points like those from the sites mentioned here.

Some researchers believe that Potočka Zijalka and Mokriška Jama can be clearly associated with the Aurignacian (see Brodar & Osole, 1979; Brodar & Brodar, 1983; Allsworth-Jones, 1990). However, the archaeological assemblages of Potočka Zijalka display both some differences from, and also some similarities to, other mentioned sites. Besides many bone points, the archaeological assemblage of Potočka Zijalka also contains many stone tools, which is not true for Mokriška Jama, Divje Babe, Vindija and Velika Pećina. Furthermore, the stone tools include many more distinctively Aurignacian types, particularly carinated and nosed endscrapers (see

Brodar & Brodar, 1983; Allsworth-Jones, 1990) than at these other sites. The distinct similarities to Mokriška Jama and the Croatian sites lie in the presence of characteristic bone tools and a continuation of Mousterian lithic tradition into the Upper Paleolithic. Several years ago, Hahn (1977) suggested that components comprising relatively small sample sizes of lithic tools with bone implements likely represented activity-specific (specifically hunting) foci of the Aurignacian. While this is a possible explanation for the Slovenian and Croatian sites (see also Montet-White, 1996), it should be noted that there is no obvious unique hunting activity evident for these sites, which might explain their distinctive artefactual pattern.

It may be that the industries from Vindija, Velika Pećina, Divje Babe, and Mokriška Jama are closely related and that all represent an early Upper Paleolithic industry that represents an indigenous cultural development in this region, at least in part. We believe that Potočka Zijalka is also closely related to these sites, but this last site provides the best evidence of intrusive influences into this region during the early Upper Paleolithic. This influence may well be the influx of some type of Aurignacian into this region, but once present, this intrusive influence is assimilated into a regional cultural expression that may have some roots in the local Mousterian.

Conclusion

Level G3 at Vindija contains an essentially Mousterian lithic assemblage, in which some distinctly Upper Paleolithic type items are included. Additionally, one rather crude leaf-shaped bifacial piece is present in this level and another one is derived from the lower G complex. These may be forerunners of the more typical bifacial leaf points of G1 and the upper G complex. Thus, there are indications of some technological and typological continuity between the G3 and G1 levels. We believe that the entire assemblage from level G1, including the bone points, was produced by the Neanderthal population represented by the human skeletal remains recovered from this level. We base our interpretation on the fact that cryoturbational mixing is unlikely to have caused the intrusion of neither the single split-base bone point (or all of the other bone tools) from the site nor the Upper Paleolithic type lithic elements into level G1.

Furthermore, we note that an association of Neanderthals with lithic and other items considered typical of the Upper Paleolithic has also been demonstrated at the French sites of Saint Césaire (Lévêque *et al.*, 1993) and Arcy-sur-Cure (Hublin *et al.*, 1996). Thus, such associations at Vindija are not unique and may be also the result of some type of interaction between Neanderthals and early modern Europeans, at least in part. This possibility is supported by the chronological and paleontological indications that there may have been overlap between these populations in the Hrvatsko Zagorje around 33 ka. While arteficial mixing cannot be completely rejected as a possible explanation for this association, it would seem no more reasonable an explanation, given all of the pertinent evidence, than one involving complex interaction between two different Pleistocene human populations.

A similar bone industry is present in Vindija, Velika Pećina, Mokriška Jama, Divje Babe, and Potočka Zijalka associated with stone artefacts exhibiting both Middle and Upper Paleolithic features. The stone assemblages of Vindija level G1, Velika Pećina, Divje Babe and Mokriška Jama are clearly not Aurignacian *sensu stricto*, although one Aurignacian tool type is present in Vindija G1. In Potočka Zijalka the number of Aurignacian types present is considerably greater. While the situation in Potočka Zijalka might represent what may be Central European Aurignacian, the lithic

assemblages from the other sites reflect either a continuation of the Mousterian technological tradition (Vindija G1) with the inclusion of Upper Paleolithic elements or a regional Upper Paleolithic variant with distinct connections to the Mousterian. In any case, we conclude that the term Aurignacian should not be used for the early Upper Paleolithic in these Croatian and Slovenian sites, at least not in any pan-European sense. This is because the early Upper Paleolithic in these sites is unique in many ways and does not conform to the classic Aurignacian pattern. Furthermore, in some areas, like the Hrvatsko Zagorje, the early Upper Paleolithic potentially has roots in the Middle Paleolithic, from which it developed, combined with what was likely significant external influences. It may be that some of these influences correspond to the appearance of early modern people in this region, but it is important to remember that some aspects of the early Upper Paleolithic were already developing before these populations arrived.

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