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A cautionary tale from the Adriatic Palaeolithic: reassessing the stratigraphic reliability of Šandalja II cave (Istria, Croatia)

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ABSTRACT
Šandalja II has been a reference site for numerous decades for the definition and study of the Eastern Adriatic Upper Palaeolithic and corresponding techno-complexes. This is due both to its extensive material record, and the purported presence of some otherwise elusive techno-complexes in the area, such as the Aurignacian and the Early Epigravettian. In this paper, we present two new series of C14-AMS dates (from layers H, E, C/d and A/d) to assess the validity of its archaeological sequence, together with previously obtained radiocarbon dates, both AMS and conventional. The results show, unambiguously, the lack of reliability of the stratigraphy defined for the site during the excavation. A simple chronometric deconstruction reveals, at the very least, that the assemblages from Šandalja II can no longer be considered and used as an example of the diachronic evolution within the Aurignacian and Epigravettian of the Eastern Adriatic, thus calling for a further re-evaluation of features defined for the Adriatic Upper Palaeolithic on the basis on the assemblages from Šandalja II. Hence Šandalja II joins an increasing list of so-called reference sites which must not be considered as "referential" anymore.

KEY WORDS
Upper Palaeolithic,
Aurignacian,
Epigravettian,
Adriatic Basin,
Šandalja II cave,
radiocarbon dating,
stratigraphy,
chronology.

RÉSUMÉ
Un récit édifiant du Paléolithique adriatique : réévaluer la fiabilité stratigraphique de la grotte de Šandalja II (Istrie, Croatie).
Depuis de nombreuses décennies, Šandalja II est considéré comme un site de référence pour la définition et l'étude du Paléolithique supérieur de la mer Adriatique orientale et des techno-complexes associés. Cela est dû à la fois à ses archives matérielles de vaste ampleur et à la présence supposée de certains techno-complexes rares dans la région, tels que l'Aurignacien et l'Épigravettien ancien. Dans cet article, nous présentons deux nouvelles séries de dates C14-AMS (à partir des couches H, E, C/d et A/d) permettant d'évaluer la validité de cette séquence archéologique, ainsi que celle des datations au radiocarbone obtenues précédemment, à la fois AMS et conventionnelles. Les résultats montrent, sans ambiguïté, le manque de fiabilité de la stratigraphie définie lors de la fouille. Une simple déconstruction chronométrique révèle, à tout le moins, que les assemblages de Šandalja II ne peuvent plus être considérés et utilisés comme exemple de l'évolution diachronique au sein de l'Aurignacien et de l'Épigravettien de la mer Adriatique orientale, impliquant une réévaluation des caractéristiques du Paléolithique supérieur Adriatique aujourd'hui définies à partir de l'étude de Šandalja II. Ainsi, Šandalja II rejoint une liste toujours plus longue de sites dits de « référence », mais dont le statut doit être dorénavant reconsidéré.

MOTS CLÉS
Paléolithique supérieur, Aurignacien, Épigravettien, mer Adriatique, grotte de Šandalja II, datation radiocarbone, stratigraphie, chronologie.

INTRODUCTION

The definition of a techno-complex is an arduous but essential task for Pleistocene archaeology, as it allows for the integration of local sites into wider regional units and overviews, and thus provides a first insight into large-scale processes. It has long been recognised, however, that the exact nature of these techno-complexes is not easy to assess in view of their duration and geographical extent. In this sense, their use and interpretation, for instance as structuring units in interdisciplinary work such as ancient DNA, is not straightforward and should be handled with great theoretical and methodological caution (see Roberts & Vander Linden 2011).

In addition to these well-known issues, lies the apparently simple, but equally fundamental, problem of the material definition of a techno-complex. The corresponding literature is extensive, and here is not the place to review the different techniques and long debates which have animated the discipline for more than a century. For the present purpose, it is only worth reminding that, in many instances, the factual definition of techno-complexes rests upon the analysis of a relatively restricted set of key sequences which own a privileged status due to numerous reasons (e.g. early date of excavation, size of the assemblage, duration of the sequence, identity of the first analyst). As further explored through a given example in this contribution, the integrity of such key sequences is sometimes difficult to assess due to old excavations, incomplete archives, and related documentary issues. Such problems, and their implications for the definitions of the corresponding techno-complexes, must however be kept in mind and, when possible, assessed at the risk of generating damaging mistakes, amplified further down through uncritical re-use of the original interpretations.

An example of such possibly treacherous sequence is provided here by the site of Šandalja II, a key cave site for the Early and Late Upper Palaeolithic in the Eastern Adriatic. The site is well known for its rich lithic (Malez 1974, 1987; Karavanić 1999; 2003; Karavanić *et al.* 2013) and faunal assemblages (Miracle 1995, 1996; Brajković & Miracle 1997; Brajković 2000; Miracle 2007), together with human remains (Malez 1972; Janković *et al.* 2011, 2012), osseous industry (Karavanić *et al.* 2013), mobiliary art (Čujkević-Plečko & Karavanić 2018; Ruiz-Redondo *et al.* 2020) and personal ornaments (Cvitkušić & Komšo 2015). The lower part of the deposited layers belongs to the Early Upper Palaeolithic Aurignacian techno-complex, while the upper part is attributed to the Late Upper Palaeolithic Epigravettian techno-complex. The very top of the sequence was deposited during the Holocene (Karavanić *et al.* 2013).

Šandalja II represents one of the most important sites, together with Crvena Stijena (Whallon 2017) and Badanj (Basler 1976), for the early years of Late Upper Palaeolithic research in the Eastern Adriatic. Due to a combination of extensive radiocarbon dating (Malez & Vogel 1969), deep stratigraphic sequence, and extensive archaeological assemblages, Šandalja II is a regional reference point for studying Eastern Adriatic Epigravettian industry and its chronology (Basler 1983; Karavanić 1999), and for the Early Upper Palaeolithic since it is the only site in the eastern Adriatic to have yielded stratified Aurignacian deposits (Karavanić 2003; Karavanić & Janković 2010; Karavanić & Vukosavljević 2019).

SITE BACKGROUND

Šandalja II cave was discovered in 1962 in a quarry 4 km northeast of Pula (44°52'57"N, 13°53'48"E; Fig. 1). It was excavated over 22 campaigns between 1962 and 1989 under the direction of Mirko Malez (Miracle 1995). It is located a few meters to the north from the cave called Šandalja I (Malez 1963), discovered in 1961. It is almost certain that Šandalja I and II belonged to the same cave complex (Miracle 1995).

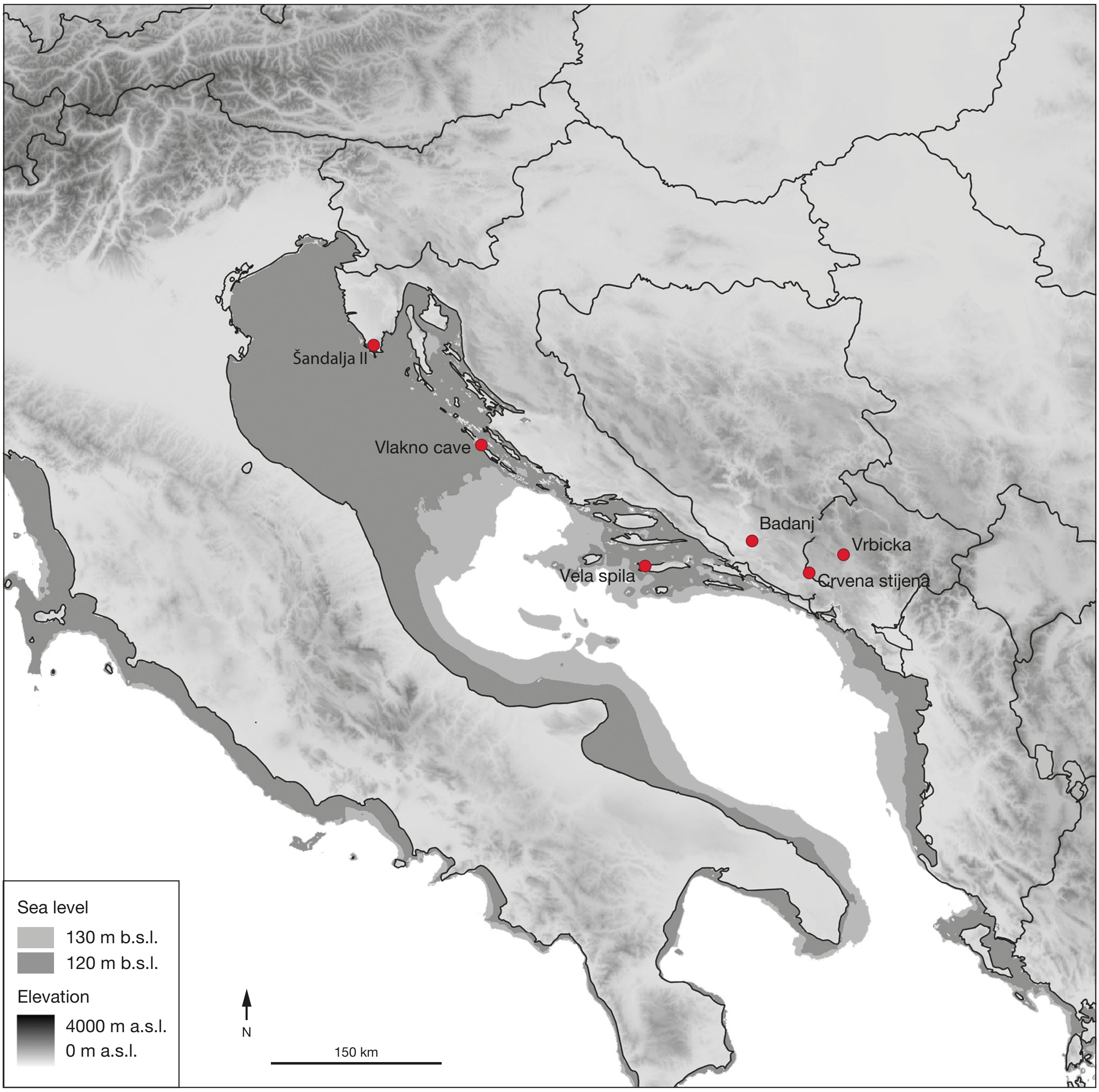

FIG. 1. — Location of Šandalja II and other Upper Palaeolithic sites mentioned in the text.

The cave itself was largely destroyed by further work in the quarry, and today only very limited remains are visible. At the time of its discovery, Šandalja II was filled almost to the top with sediments rich in faunal remains and stone artefacts (Fig. 2).

The stratigraphic sequence is over eight meters thick and is divided by Malez into eight strata labelled from A to H, where A indicates the youngest and H the oldest levels (Malez 1963, 1964, 1979; Malez & Vogel 1969). Deposits C and B are thicker and form complexes which are divided into several layers. Complex B consists of layers B/g (top), B/s (middle), B/d (bottom), and the same applies to the sub-divisions of complex C. However, symbols for stratigraphic units within the above two complexes were set one on top of another and do not reflect different sedimentation or changes in the colour of the sediment, so that the sub-division appears somewhat arbitrary (Miracle 1995; Karavanić 2003: 580). Figure 2A shows the eastern, stratigraphic profile exposed in 1962 which M. Malez used for sedimentological description (Malez 1963, 1979). For the description of strata A to D, Miracle (1995) used the profile from the natural entrance to the cave from 1976. He noticed that 'there are, however, rather significant discrepancies between estimates of mean level thickness given by Malez and those measurable on the entrance profile (Miracle 1995: 90). Detailed strata descriptions

FIG. 2. — Šandalja II cave: **A**, eastern profile initially exposed in 1962; **B**, image of the upper strata where it is clearly visible that **A** and **B** are not perfectly horizontal layers (as presented by M. Malez, 1972); **C**, **D**, illustrations of the invasive field techniques used to handle the spoil, including bulldozer and conveyor belt. Credits: Institute for Quaternary Paleontology and Geology in Zagreb, Croatian Academy of Sciences and Arts photo archive.

are provided by Malez (1963, 1979) and Miracle (1995). We possess only fragmented archives on the excavation of the site. Only a portion of the excavated sediments underwent sieving (Miracle 1995), and it appears to no two-dimensional, let alone three-dimensional, recording or plotting of individual finds was ever undertaken.

M. Malez (1963, 1979) recognized four main chrono-cultural units, from top to bottom:

– Layer A: Holocene deposit including Neolithic and Bronze Age finds;
– Layer B: Late Upper Palaeolithic Tardigravettian complex;
– Layer C: Gravettian techno-complex deposit;
– Layers D to H: Aurignacian deposit.

Malez (1990) also mentioned the existence of layers older than H, but they do not appear in any of the published drawings of the stratigraphic profile. Karavanić (1999: 581) has suggested that this is due to the fact that these lower layers were excavated in the last campaigns, when the majority of the works on the stratigraphy of the site was already published.

Karavanić (1999) also challenged Malez's initial cultural attribution of the different layers after re-examining the lithic assemblages. While he respected the Holocene component of layer A, he assigned layers B and C to the Epigravettian, attributing the lower part of the later (C/d) to the Early Epigravettian. Layer D presents a mixture of Aurignacian and Epigravettian materials, and layers E to H correspond to the Aurignacian. It is noteworthy that Karavanić describes the infiltration of pieces from the Epigravettian layers as deep as in the sub-layer G/H, at the bottom of the sequence and over 1.5 m deeper than the oldest Epigravettian layer otherwise identified.

Despite its importance, the integrity of the Šandalja II record has been questioned (e.g. Miracle 1995; Karavanić 2003; Karavanić *et al.* 2013; Ruiz-Redondo *et al.* 2020; Vukosavljević 2023), and the incoherence between some of the radiocarbon results has suggested mixing within some layers (Miracle & Brajković 2013; Oros Sršen *et al.* 2014; Richards *et al.* 2015). For instance, the most recent of these publications showed discrepancies of up to 5000 years between two dates from the same purported Late Epigravettian layer (B/g), with one falling within the chronological range of the Holocene (*c.* 9000 cal BP).

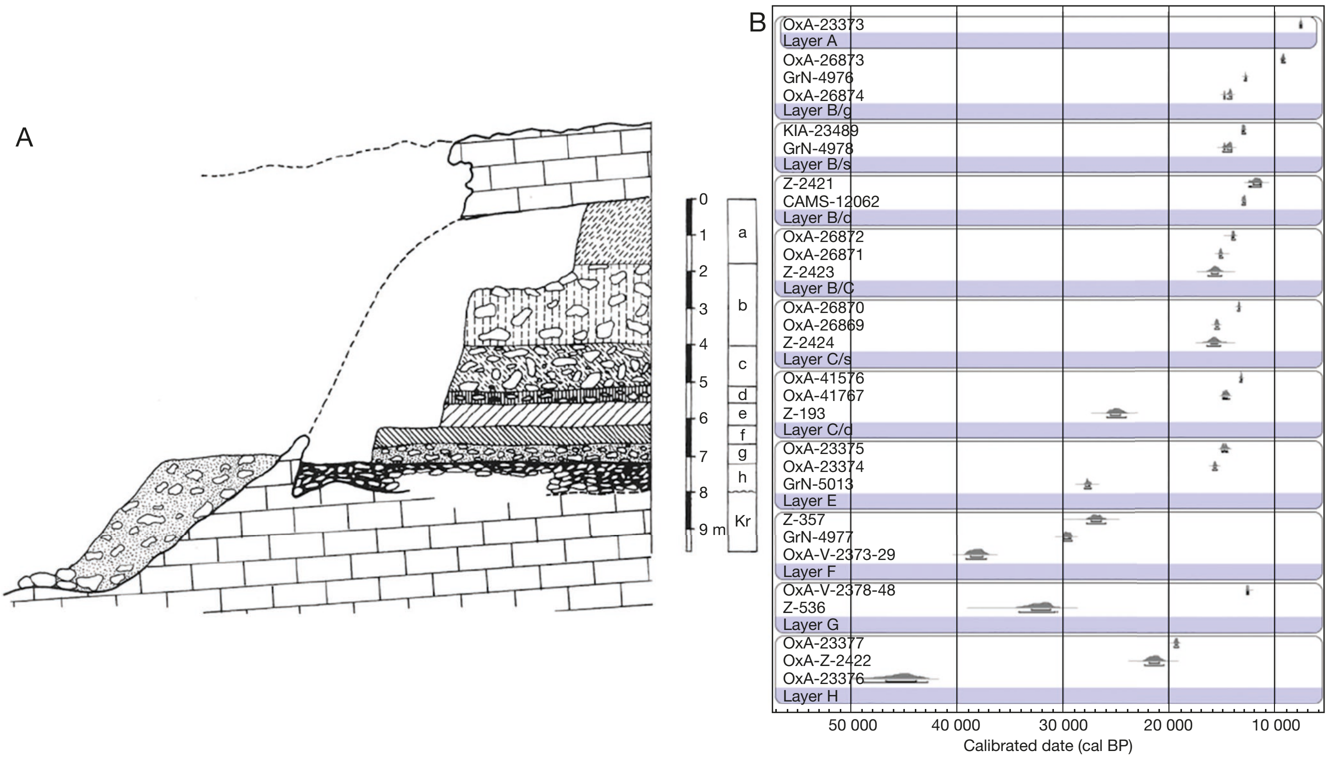

FIG. 3. — **A**, Stratigraphic profile as drawn by Malez (1979); **B**, distribution of calibrated available radiocarbon dates, grouped by stratigraphic attribution following Malez's sequence.

METHODS AND RESULTS

METHODS

To further assess the reliability of the Šandalja II stratigraphic and chrono-cultural sequence, we present here two new independent series of ^{14}C-AMS results (Table 1; Fig. 3B). In each case, the samples were acquired from the Šandalja II collections hosted by the Institute for Quaternary Paleontology and Geology, Croatian Academy of Sciences and Arts. All samples consist of animal bones showing evidence of human activities (cut-marks for 6 of the samples and a domestic species for the other). The first series was undertaken by M. Vander Linden to verify the integrity and precise chronology of the Neolithic and Aurignacian layers. It consists of two horses' ribs with cut-marks from layer H ("Aurignacian"), two further horse ribs with cut-marks from layer E ("Aurignacian"), and an *Ovis*/*Capra* proximal left metatarsal from layer A/d ("Early Neolithic Impressa"). The two other new dates were obtained by A. Ruiz-Redondo and N. Vukosavljević and correspond to animal remains from layer C/d showing anthropogenic transformations. The first one corresponds to a distal end of a European badger (*Meles meles* (Linnaeus, 1758)) humerus, and the second one to a proximal end of a red deer (*Cervus elaphus* Linnaeus, 1758) radius.

Bone samples were prepared for radiocarbon dating following the standard protocols in place at the Oxford Radiocarbon Accelerator Unit, School of Archaeology, University of Oxford. This procedure involves an acid-base-acid pre-treatment, and an ultrafiltration step (Brock *et al.* 2010, 2013). Calibration was performed using the Intcal20 calibration curve (Reimer *et al.* 2020) and using the software Oxcal 4.4 (Bronk Ramsey 2017). All results are reported in Table 1, and all dates mentioned hereafter use a two-sigma calibration (95.4% probability). Figure 3 provides a graphical illustration of the distribution of all existing dates, contrasted with their stratigraphic position.

RESULTS

Date OxA-23373 provides the first absolute chronological information for stratigraphic complex A. Its date to the mid-8th millennium cal BP is compatible with the expectations based on typo-chronological attribution of the associated material culture, as it falls within the range of known dates for the Adriatic Early Neolithic (Vander Linden & Silva 2021).

The two new dates for layer C/d present a good precision and provide two closely related ages (OxA-41767: 14 950-14 320 cal BP; OxA-41576: 13 300-13 100 cal BP). However, their relationships with the pre-existing radiocarbon chronology of the site are difficult to assess, as they are both *c.* 10 000 years younger than the other available date for Layer C/d. However, they appear as relatively consistent with dates from the upper Layer C/s, as well as from the transition between Layers B/C.

A total of four new dates were also acquired for Layers E and H which bracket the assumed Aurignacian presence on the site. The two recently obtained dates for layer E provide consistent results between 15.8 and 14.3 ka cal BP, but differ significantly from existing date GrN-5013 by *c.* 12 000 years. The new dates for layer H equally provide mixed results. One sample (OxA-23336) is close to the limit of the radiocar-

TABLE 1. — Radiocarbon dates available for Šandalja II. Abbreviations: **AB**, animal bone; **HB**, human bone; **UF**, ultrafiltration; **WC**, wood charcoal.

Layer	Material	Species	AMS	UF	Lab No.	uncal BP	±	d13C	d15N	%C	%Yield	CN	cal BP (2σ)	Reference
A/d (3642)	AB	*Ovis/Capra*	yes	yes	OxA-23373	6731	37	–20.5	6.8	37.7	1.1	3.2	7670-7520	this paper
B/g	AB	*Alopex lagopus* (Linnaeus, 1758)	yes	yes	OxA-26873	8251	39	–19.4	6.9	42	2.3	3.2	9410-9030	Oros Sršen *et al.* 2014
B/g	AB	bulk sample of several bones	no	–	GrN-4976	10830	50	–19.9	–	–	–	–	12880-12720	Malez & Vogel 1969
B/g	AB	*Equus hydruntinus* (Regalia, 1907)	yes	yes	OxA-26874	12295	55	–21.5	4.8	43.4	4.2	3.2	14820-14070	Oros Sršen *et al.* 2014
B/s	HB	possible identification	yes	–	KIA-23489	11025	60	–20.8	13.1	44.2	2.4	3.5	13100-12780	Richards *et al.* 2015
B/s	WC	–	no	–	GrN-4978	12320	100	–23.9	–	–	–	–	14890-14050	Malez & Vogel 1969
B/s	WC	–	yes	–	CAMS-12062	10990	60	–	–	–	–	–	13070-12770	Miracle 1995
B/d	AB	bulk sample of several bones	no	–	Z-2421	10140	160	–	–	–	–	–	12470-11250	Obelić *et al.* 1994
B/C	AB	*Capreolus capreolus* (Linnaeus, 1758)	yes	yes	OxA-26872	12035	55	–20.2	5	42.3	4.1	3.2	14050-13800	Oros Sršen *et al.* 2014
B/C	AB	*Gulo gulo* (Linnaeus, 1758)	yes	yes	OxA-26871	12680	55	–19.3	6.2	42.5	2.8	3.2	15290-14950	Oros Sršen *et al.* 2014
B/C	AB	bulk sample of several bones	no	–	Z-2423	13050	220	–	–	–	–	–	16310-15010	Obelić *et al.* 1994
C/s	AB	*Capreolus capreolus* (Linnaeus, 1758)	yes	yes	OxA-26870	11515	50	–20.8	3.9	42.6	2.9	3.2	13490-13300	Oros Sršen *et al.* 2014
C/s	AB	*Equus caballus* (Linnaeus, 1758)	yes	yes	OxA-26869	12940	55	–20.2	7.4	43.6	1.8	3.2	15660-15270	Oros Sršen *et al.* 2014
C/s	AB	bulk sample of several bones	no	–	Z-2424	13120	230	–	–	–	–	–	16440-15080	Oros Sršen *et al.* 2014
C/d	WC	bulk sample of several charcoal fragments	no	–	Z-193	20750	400	–	–	–	–	–	25860-24050	Srdoč *et al.* 1973
C/d (10951)	AB	*Meles meles* (Linnaeus, 1758)	yes	yes	OxA-41767	12454	44	–20.1	9.2	43.5	2.1	3.3	14950-14320	this paper
C/d (2240)	AB	*Cervus elaphus* (Linnaeus, 1758)	yes	yes	OxA-41576	11289	42	–21.4	4.2	42.6	0.6	3.2	13300-13100	this paper
E	AB	bulk sample of several bones	no	–	GrN-5013	23540	180	–19.4	–	–	–	–	28020-27320	Malez & Vogel 1969
E (9450)	AB	*Equus* sp.	yes	yes	OxA-23374	13060	60	–20..2	6	40.5	0.8	3.2	15850-15410	this paper
E (9727)	AB	*Equus* sp.	yes	yes	OxA-23375	12505	55	–20.6	6.5	41.7	2.5	3.2	15060-14340	this paper
F	WC	–	no	–	Z-537	22660	460	–24	–	–	–	–	27740-26010	Srdoč *et al.* 1979
F	AB	bulk sample of several bones	no	–	GrN-4977	25430	170	–19.5	–	–	–	–	29980-29220	Malez & Vogel 1969
F	AB	mammal	yes	yes	OxA-V-2373-49	33355	290	–18.9	8	25.9	2	3.6	39160-37210	Richards *et al.* 2015
G	AB	mammal	yes	yes	OxA-V-2378-48	10580	39	–20.2	8.4	41.1	2	3.5	12700-12490	Richards *et al.* 2015
G	WC	–	no	–	Z-536	27800	800	–24	–	–	–	–	34220-30500	Srdoč *et al.* 1979
H	AB	bulk sample of several bones	no	–	Z-2422	17600	370	–	–	–	–	–	22280-20480	Obelić *et al.* 1994
H (9550)	AB	*Equus* sp.	yes	yes	OxA-23376	42300	1500	–19.9	7.4	41.7	3.3	3.2	48890-42820	this paper
H (9550)	AB	*Equus* sp.	yes	yes	OxA-23377	15965	75	–20.1	5.2	40.6	0.8	3.2	19490-19080	this paper

bon technique, as reflected by its large standard deviation of 1 500 years (*c.* 49-43 ka cal BP). If correct, this date would put the level towards the very beginning of the Aurignacian in the Balkans (Nett *et al.* 2021). It must be emphasized that the small lithic assemblage found in layer H can be determined only as Upper Palaeolithic without precise cultural attribution, i.e., Aurignacian (Karavanić 2003). This radiocarbon determination could alternatively provide a terminus *ante quem* for the elusive older layers mentioned by Malez but for which, as said, there is no further evidence in the stratigraphy drawings or the rest of the archives. The second date (OxA-23337) from layer H is much younger and too recent for the expected chronological range of the Aurignacian. Interestingly though, it is relatively close to another date previously obtained for that layer (Obelić *et al.* 1994), which had originally been dismissed due to its stratigraphic position at the bottom of the sequence and apparent incoherence with older dates available for layers G and F (Karavanić 2003: 581).

DISCUSSION

It is apparent from this brief presentation that the distribution of radiocarbon dates does not follow the expected chronology based upon the stratigraphic sequence. This preliminary result seems to confirm numerous earlier indications which suggested a certain level of inconsistency in the absolute chronology of Šandalja II. While some of the existing radiocarbon dates have for instance been dismissed as outliers, our new sampling recurrently raises problems, and thus asks for systematic evaluation. Several factors can potentially explain the state of affairs:

– counting errors by the various radiocarbon laboratories involved;

– archival and storage issues;

– inconsistency of the original recording during the excavations by Malez;

– lack of integrity of parts or of the entire stratigraphy;

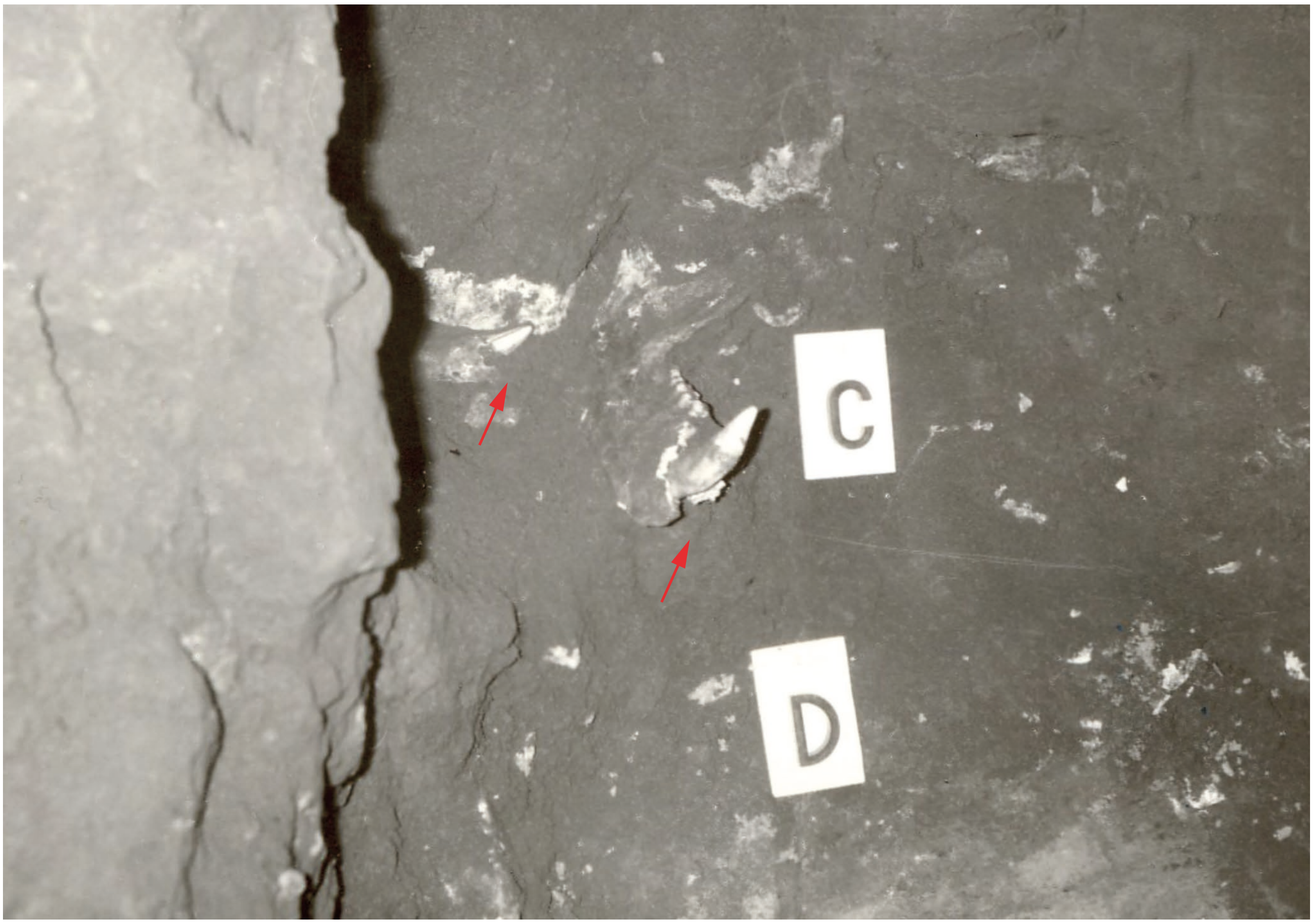

Fig. 4. — Picture showing the transition between Layers C and D in the Šandalja II stratigraphic profile. The two **red arrows** point to mandibles of cave bear.

– a combination of two or several of these factors.

The first factor to consider is the possibility that not all available radiocarbon dates are accurate. Such problem can happen for a variety of reasons, such as contamination, collagen preservation, or mistakes during the counting stage itself. The impact of this particular problem is potentially acute here given that we are dealing with dates obtained over a very long period of time, including some at the very early stages of development of the technique, plus the fact that our samples come from varied laboratories and thus combine both AMS and non-AMS dates. Regarding the dates first reported here, we have already noted that one of our samples lies at the edge of the calibration curve. Given its large standard-deviation and the fact that it does not match any other dates for this entire archaeological complex, it is probably safe to discard it. By contrast, for all other recent samples, nothing a priori suggests that the absolute ages obtained are not consistent with the real age of the sample, which is distinct from the expected age of the layer and/or associated techno-complex (see below). As such, we can reasonably consider that the dates first reported by Oros Sršen and colleagues (2014) are equally reliable, as they were processed by the same laboratory using the same high methodological standards. However, it is much more difficult to assess independently the validity of the dates from the 1960s, 1970s, and 1990s as they were not processed by AMS, were not treated via ultrafiltration, include several bulk samples, and some present large standard deviation. In this sense, these should be considered with caution, as shown by other dating programmes for comparable periods (e.g. Higham *et al.* 2006; Higham 2011). This being said, it is worth noting that, generally, ultrafiltration yields older ages than samples not treated accordingly, which is not the case here. All in all, aside from the aforementioned very early date, it is therefore impossible to identify clearly any inaccurate dates solely on grounds related to the radiocarbon technique itself.

The second problem implies the possibility of mislabelling or other activities compromising the integrity of the archives during their storage. This issue should not be overlooked, especially given that the collections have been curated over several decades. However, following previous dating programmes on the same site (Oros Sršen *et al.* 2014), personal experience by one of the co-authors when handling the collections for studying lithic material, and given the history of the host institution, there is no reason to believe that such problems may have occurred.

The last two main factors, i.e., lack of stratigraphic integrity and difficulties in identifying this during the original excavations, are almost by definition near impossible to disentangle.

Several convergent lines of evidence point into this direction. Firstly, as we have seen, the excavation techniques, while of their time, were not adequate to identify the subtle stratigraphic variations which generally characterise Pleistocene cave sedimentation. Secondly, other authors, most notably Miracle (1995; see also Miracle & Brajković 2013), have already identified discrepancies between Malez's and their own observations of the then preserved profiles. Thirdly, Karavanić identified the presence of intrusive lithic pieces in the various assemblages, thus hinting at potential vertical movement between layers. Lastly, we recently found a picture in the Malez archives showing the transition between layers C and D, attributed to the Epigravettian and the Aurignacian, respectively. As shown on Figure 4, there is a clearly visible cave bear jaw (and possibly a second one) at the bottom of layer C (probably C/d, considering the position). This is noticeable as this species went extinct at *c.* 24 ka cal BP (Terlato *et al.* 2019). If the stratigraphy is coherent, this date would provide a terminus ante quem for layers D and below, and conversely a terminus post quem for layers C and above. While this information is consistent with some of the old dates, it would not explain the dates more recently obtained. Further, it would imply a gap of several millennia between layers C/d and C/s, for which there is no other independent indication.

The above analysis thus indicates that the Šandalja II stratigraphic sequence presents a limited stratigraphic integrity, and that existing descriptions as a straightforward succession of bounded layers are inaccurate. From a radiocarbon point of view, this means that, while each date is likely to inform us to some extent about real past events, it is impossible in the present state of the documentation to assess the fundamental link between what is being dated (i.e., the biological death of the organisms being sampled), and the suggested associated archaeological complex. The archaeological implications for our understanding and factual definition of the Upper Palaeolithic in the Eastern Adriatic are two-fold.

In his review of the Aurignacian industries of the site, Karavanić (2003: 599) had already noticed the very long duration of this techno-complex at the site, but conditioning this affirmation to the reliability of the radiocarbon dates then available. In view of the present results and discussion, it rather appears that the stratigraphy is more complex than originally stated, taphonomy control was not carefully performed and a part of material is mixed between different Aurignacian layers, so that in the current state of the documentation it is difficult to warrant systematically the identity of the archaeological items assigned to them. Therefore, any division of the Aurignacian lithic material of Šandalja II into several phases (Malez 1987; Karavanić 2003) lost its meaning, while the dating results (Srdoč *et al.* 1979; Richards *et al.* 2015) might point to the late Aurignacian.

The same general conclusion holds for the Epigravettian component. Layer C/d bears a special interest due to the techno-complex that is reported to represent: the Early Epigravettian. This period is barely known and poorly characterised for the Eastern Adriatic. Only four sites in the area have layers dated to Early Epigravettian, namely Šandalja II - layer C/d (Karavanić *et al.* 2013), Vlakno cave – horizon II (Malnar 2017; Cvitkušić *et al.* 2018), Vela Spila - LUP-A and LUP-B horizons (Vukosavljević 2012; Vukosavljević *et al.* 2022) and Vrbička cave (Borić *et al.* 2014). In addition to the low number of sites, it is noteworthy that the characteristics of the data and information available are equally difficult. First, Early Epigravettian assemblages are usually small, and they come from test pits or small excavated areas. Second, the distinction between Early Epigravettian and Late Gravettian is problematic based on the archaeological material (Mihailović 2014), as it can be between the Early and the Late Epigravettian (Vukosavljević 2023). This makes that the attribution of some of these layers rely heavily to their radiocarbon dating. It should be noted that Gravettian remains are not found in Šandalja II. The Eastern Adriatic Mid-Upper Paleolithic record, preceding the Epigravettian, is exceedingly rare. Merely three sites have been 14C dated, indicating an age older than 25 000 cal BP but younger than the Aurignacian technocomplex. These sites include Abri Kontija and a Cave near Rovinjsko Selo 1 in Istria, as well as Vrbička Cave in western Montenegro. Abri Kontija has deposits dating back approximately to 30 000 cal BP (Ivor Janković, personal communication, September 2020). Recent investigations at Vrbička Cave unveiled layers dating to roughly 28 000-27 000 cal BP (Borić & Cristiani 2016), whereas those from the Cave near Rovinjsko Selo 1 indicate an age of about 31 000-30 000 cal BP (Peresani *et al.* 2021). Although the specific lithic assemblages in these caves have yet to be published, based on the available 14C dates, they are likely to be considered as sites from the Gravettian period. Subsequent lithic analyses will shed light on the cultural classification of these assemblages (Vukosavljević 2023).

Šandalja II is exceptional in this regard as its material record is numerous and it comes from a large excavation area. This largely explains its key role of as reference sequence to define several techno-complexes, especially one with such a sparse record as it is the Early Epigravettian. Both Đ. Basler (1983) and I. Karavanić (1999) relied on Šandalja II stratigraphic sequence to establish the chronology and features for the two phases that form the Late Upper Palaeolithic in the Eastern Adriatic: Early and Late Epigravettian. While for the latter a number of important sites were available (e.g. Badanj, Crvena Stijena), for the former only Šandalja II was reported to have a robust corpus of Early Epigravettian artefacts (the other three sites were yet to be discovered/studied). According to I. Karavanić (1999: 113, 114), Early Epigravettian (layer C/d) is marked by high incidence of microgravettes and backed bladelets and low incidence of segments, while these trends are opposite in Late Epigravettian (layers B/d, B/s and B/g). Furthermore, blade production during Early Epigravettian is more intense than the bladelet production, while in Late Epigravettian it is the opposite. Therefore, the definition of the Early Epigravettian for the whole Eastern Adriatic basically grounds on the layer C/d from Šandalja II, and its chrono-cultural attribution heavily relied on its sole radiocarbon dating. However, our results clearly question the validity of this second assumption.

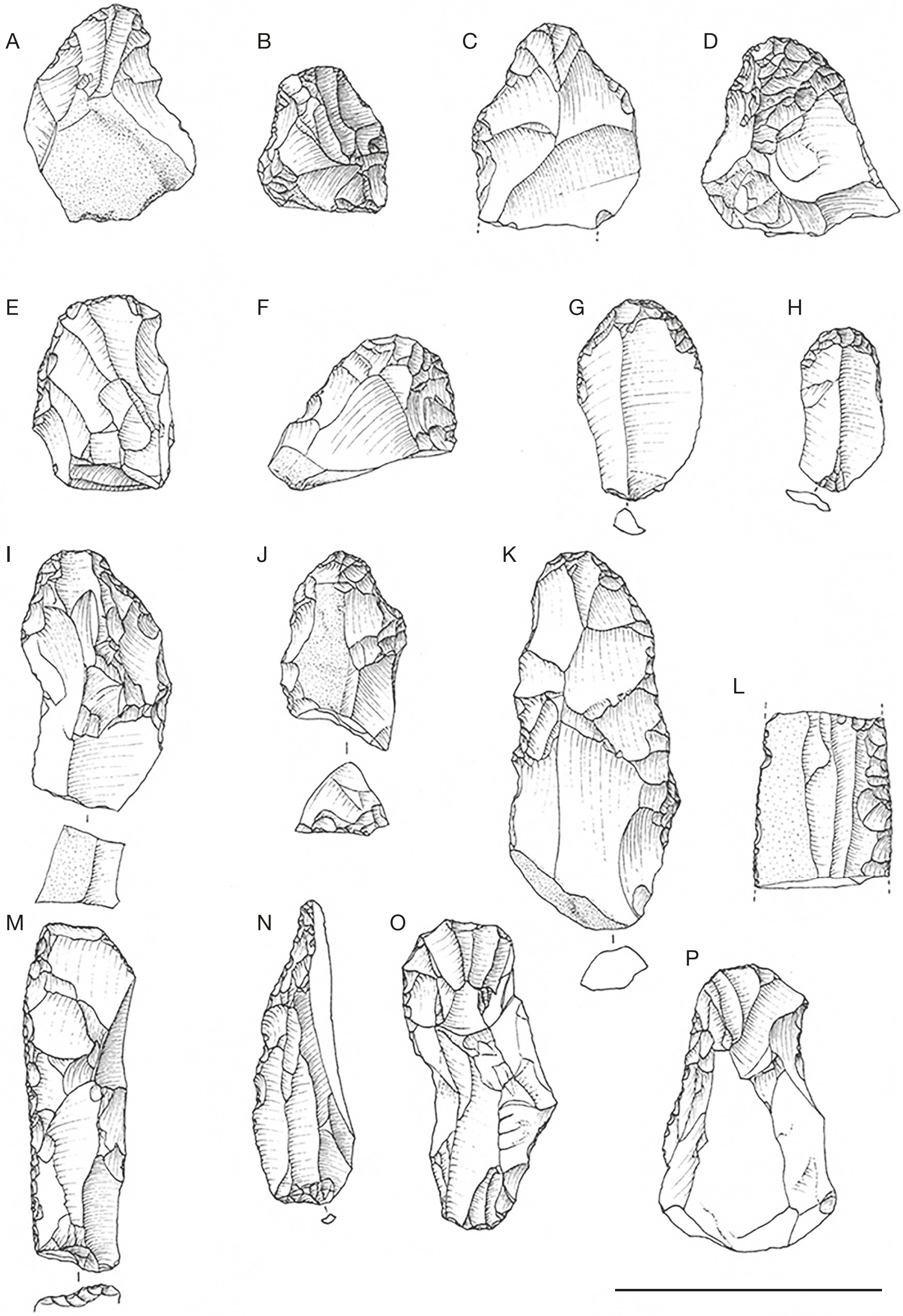

Fig. 5. — Selected stone tools from layers F and E (Aurignacian). Layer F: **A**-**D**, **I**, **J**, nosed endscrapers; **E**, atypical carinated endscraper; **F**, endscraper on flake; **G**, **H**, simple endscrapers; Layer E: **K**, **O**, **P**, carinated endscrapers; **L**, blade with two continuously retouched edges; **M**, blade with one continuously retouched edge and truncation; **N**, atypical perforator. Modified after Karavanić 2009: figs 10-12. Scale bar: 5 cm. Credits: drawing by Marta Perkić.

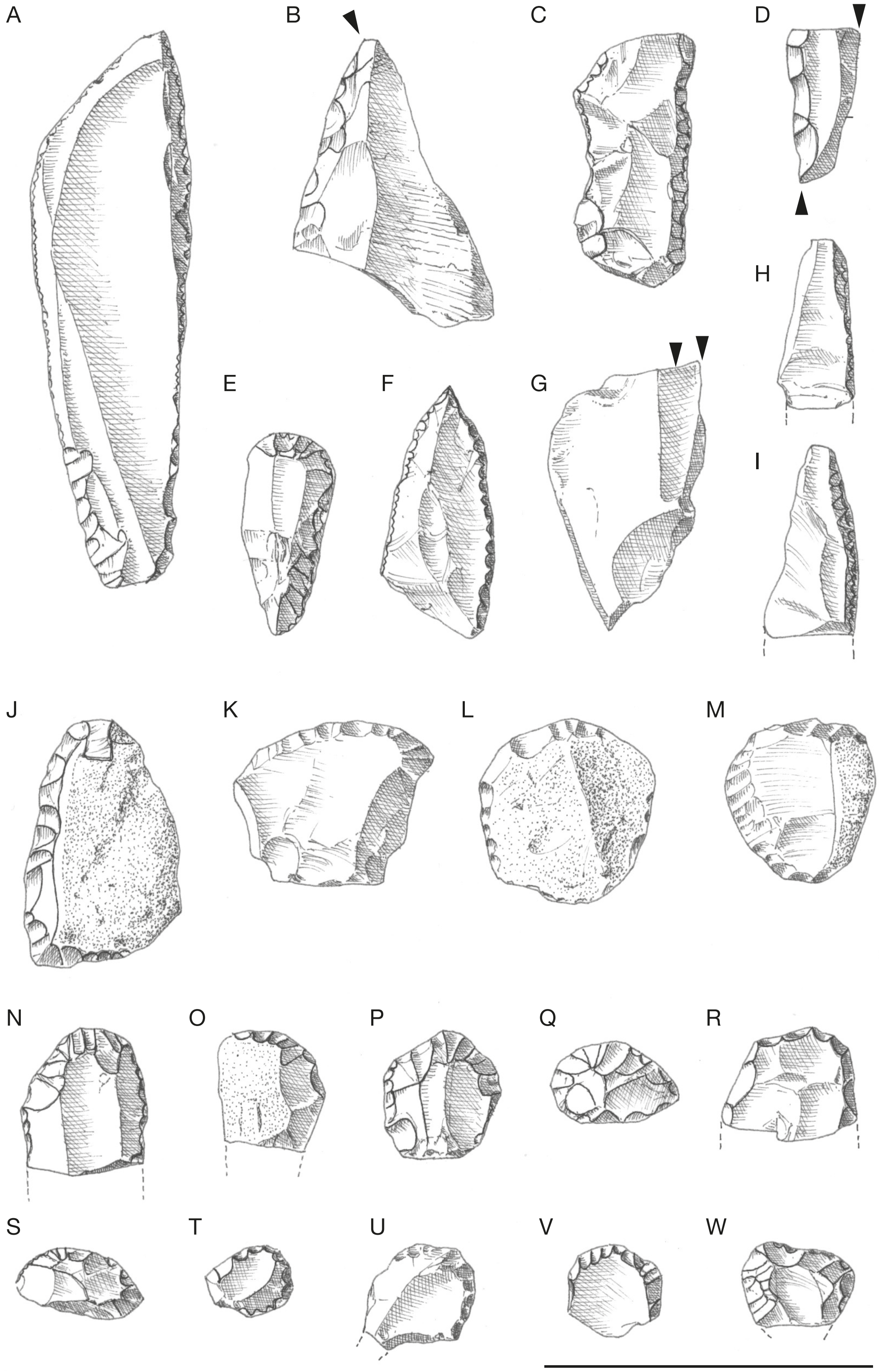

FIG. 6. — Selected stone tools from layer B/s (late Epigravettian): **A**, **C**, pieces with two retouched edges; **B**, transverse burin on lateral truncation; **D**, multiple dihedral burin; **E**, **N**, **R**, endscrapers on retouched blade or flake; **F**, perforator; **G**, nucleiform endscraper; **H**, **I**, complete backed blades; **J**, double endscraper; **K**, **O**, simple endscrapers; **L**, **M**, endscrapers on flakes; **P**, **Q**, **S**-**W**, thumbnail endscrapers. Modified after Janković *et al.* 2011: fig. 2. Scale bar: 5 cm. Credits: drawing by Krešimir Rončević.

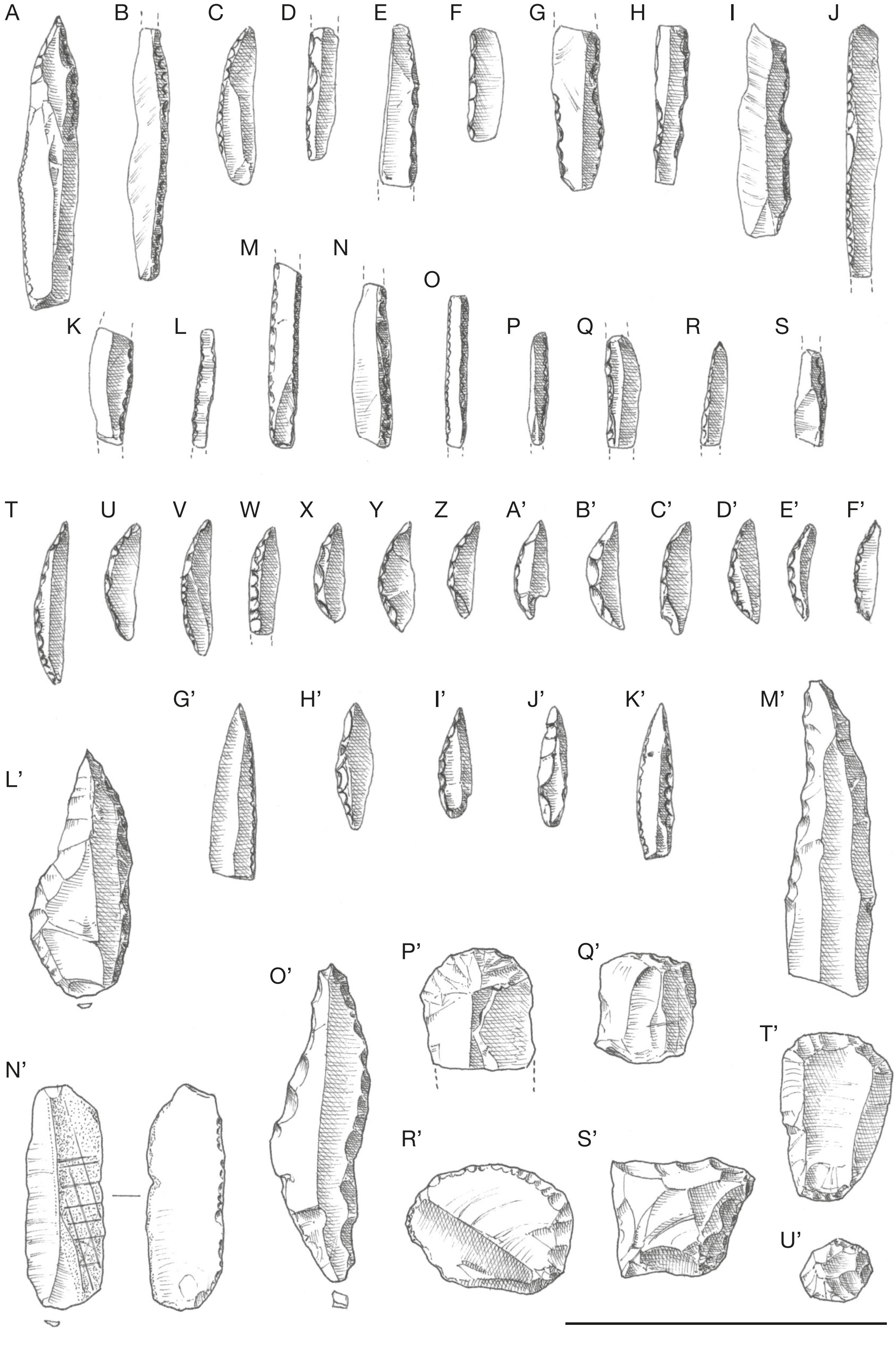

Fig. 7. — Selected stone tools from layer B/s (late Epigravettian): **A**, **L'**, perforators; **B**, **D**-**F**, **J**-**L**, **N**, **P**, **Q**, **S**, backed bladelets; **C**, **W**, **C'**, **H'**-**K'**, Azilian points; **G**, notched bladelet; **H**, rectangle; **I**, denticulated bladelet; **M**, **O**, truncated backed bladelets; **R**, micro-Gravette; **T**-**V**, **X**-**B'**, **D'**-**F'**, circular segments; **G'**, Gravette point; **M'**, **O'**, atypical perforators; **N'**, piece retouched on one edge (and engraved lattice motif on cortex); **P'**, **Q'**, **T'**, simple endscrapers; **R'**, **S'**, endscrapers on flakes; **U'**, circular endscraper. Modified after Janković *et al.* 2011: fig. 3. Scale bar: 5 cm. Credits: drawing by Krešimir Rončević.

Indeed, as recent research set the Early/Late Epigravettian boundary at *c.* 17.5 ka cal BP (Ruiz-Redondo *et al.* 2022), our newly reported dates place, at least, a part of the archaeological remains discovered in layer C/d in the Late Epigravettian undisputedly. In this sense, the layer C/d from Šandalja II is likely to be, in the best case, a mix of materials from both Early and Late Epigravettian and, in the worst-case scenario, a mix of materials from the entire Upper Palaeolithic sequence, as suggested by the presence of comparable 14C dates in Layer H.

However, it is possible that the mixing is not as intense in every layer, considering previous analyses of lithic material which reported a very clear difference between the Aurignacian and Epigravitian lithic industries, except for layer D, where the material from these two technocomplexes seems intensively mixed (Karavanić 1999, 2003; Karavanić & Janković 2010; Karavanić *et al.* 2013). Differences between assemblages were seen in typology, raw material procurement and to some extent also in technology (Karavanić 2003; Karavanić *et al.* 2013; Peresani *et al.* 2021). Lithic finds are much numerous in the Epigravettian technocomplex than in the Aurignacian. However, in the latter, blades (produced by direct percussion with soft hammer) are more numerous than bladelets (except in layer F), while in all layers of the late Epigravettian B complex bladelets significantly prevail (Karavanić 2003; Karavanić *et al.* 2013). In addition to using a direct percussion with a soft hammer for blade production (like in Aurignacian layers), the use of another technique for blade production in Epigravettian layers of Šandalja II is also likely (Karavanić *et al.* 2013). Local cherts are almost exclusively used in the Aurignacian technocomplex while in the Epigravetian imported raw materials from northern Italy are common (scaglia rossa and biancone).

In tool assemblages nosed and carinated endscrapers are quite common in the Aurignacian of Šandalja II (Fig. 5), while short endscrapers, backed bladelets and, microgravettes are significantly represented in the Epigravettian (Figs 6; 7). Aurignacian blades and Dufour bladelets are missing from the sample, but concerning Dufour bladelets it is not clear whether this reflects a real situation at Aurignacian layers or the fact that the sediment was not sieved (Karavanić 2003, 2009). It seems that they would have been collected if present at the site, due to the fact that numerous smaller finds were found and collected from the Epigravettian layers (Fig. 7C-K').

Regardless, in view of the radiocarbon results reported here and the presence of some mixing in the lithic material, we can safely conclude that any detailed division of the lithic assemblages within general technocomplexes is unreliable.

ŠANDALJA II: A CAUTIONARY TALE

The re-evaluation of the stratigraphic integrity of Šandalja II has revealed the sequence as unreliable. This is not surprising in view of the excavation methods and, especially, that the sub-divisions of the layers do not reflect changes in the sedimentation or the colours, but are arbitrary (Miracle 1995; Karavanić 2003: 580). In an attempt to bring some "order to the chaos", I. Karavanić (1999) developed an admirable work trying to correlate each layer with its techno-complex, based in a combination of some diagnostic material and the radiocarbon dates available. Unfortunately, through this method, it is difficult to detect a mixing of layers unless there are several diagnostic pieces from different periods in the same assemblage, or in the event of having enough radiocarbon results available to clearly reveal the mixing. A quite successful yet laborious method to detect mixing between layers is the taphonomic lithic studies based on inter-layer refittings (e.g. Villa 1982; Bordes 2000; Discamps *et al.* 2023), which should be considered to be applied to every archaeological context which integrity is called into question, but it is beyond the scope of the present contribution.

CONCLUSION

The conclusion of this paper is that Šandalja II's sequence is not reliable for undertaking detailed assessments for any particular techno-complex of the Upper Palaeolithic. While Aurignacian lithics only appear below layer D and the Epigravettian is present above it (except a few items found in the Aurignacian context), a more detailed study of the temporal variability of these technocomplexes, despite obvious differences, is not possible. Given the richness, in number and in variability, of this site's archaeological record for the regional Upper Palaeolithic, this is rather unfortunate, but we consider that any conclusions –if not coming from very specific analyses of individual materials– based on the site would be heavily biased. Hence, Šandalja II joins an increasing list of "reference" sites which must not be considered as "referential" anymore, as it recently happened, for example to Pégourié for the definition of the Badegoulian sequence, evolution and traditions (Ducasse *et al.* 2019).

In the case of this Croatian site, it suffered a "lethal" combination of circumstances: an old excavation, from a rich site with probably complex taphonomy and stratigraphy that were improperly assessed in the first studies. Thus, a simple chronometric deconstruction has shown, at the very least, that the assemblages from Šandalja II can no longer be considered and used as an example of the diachronic evolution within the Aurignacian and Epigravettian of the Eastern Adriatic.

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