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A NEW LOOK AT THE RADIOCARBON CHRONOLOGY OF THE SZELETIAN IN HUNGARY

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Abstract

The Szeletian is widely known as a transitional industry between the Middle and Upper Paleolithic. Szeleta Cave, the eponymous site, is located in northeastern Hungary in the Bükk Mountains and is the only site in Hungary that produced ^{14}C dates for Szeletian levels, lying between 43.0 and 11.0 ka ^{14}C BP. In this paper we critically review the ^{14}C samples obtained at Szeleta and discuss the age of the Szeletian in Hungary. In our evaluation of the data we focus on stratigraphy, the composition of layers, and the archeological context of the samples.

INTRODUCTION

The age of the Szeletian is of key importance for the understanding of the Middle to Upper Paleolithic transition in Eastern Central Europe (Allsworth-Jones, 1986; Svoboda and Simán, 1989; Adams, 1998). Szeleta Cave represents the only site at which the Szeletian has been documented in two distinct phases and, consequently, most research on the Szeletian in Hungary was focused on this site. As a result, Szeleta Cave possesses about one-fifth of all radiocarbon dates available for the Hungarian Paleolithic.

According to scholars who have been working on Szeleta (Adams, 2002; Adams and Ringer, 2004, Ringer, 2002a, 2002b), the chronology of the Szeletian in Hungary seems to be well established between ca. 43.0 and 22.0 ka ^{14}C BP.

Here, we claim that the proposed absolute chronological framework for the Szeletian within the region results from the uncritical interpretation of sample provenance in terms of both stratigraphic and archeological contexts. Therefore, we critically evaluate the radiocarbon dates from Szeleta Cave according to modern standards for the interpretation of sample context and validity (Waterbolk, 1971; Pettitt *et al.*, 2003; Vermeersch, 2005) by considering the 1) stratigraphic integrity of the samples, and 2) their archeological context, in order to shed light on crucial problems within the age estimates for the Hungarian Szeletian.

SZELETA CAVE STRATIGRAPHY

Szeleta Cave, some 60 m in length, is located on the eastern side of Bükk Mountains, at an elevation of 349 m a.s.l. (Fig. 1). The cave is divided into four parts: the "Hall" is situated immediately north of the "Entrance", the "Main Corridor" opens to the northwest of the "Hall", and the "Side Corridor" is situated to the west (Fig. 3).

Szeleta cave was first excavated between 1906 and 1913 by Kadić (1916), then in 1928, 1936, 1947, 1966, 1989, 1999 by several scholars including international teams (Mester, 2002; Ringer, 2002b; Adams and Ringer, 2004).

Kadić illustrated 11 layers among which 9 were of Pleistocene age (Kadić, 1916), labeled from bottom to top (Fig. 2). The layers were distinguished according to color, content and structure. The most complete sequence of layers was

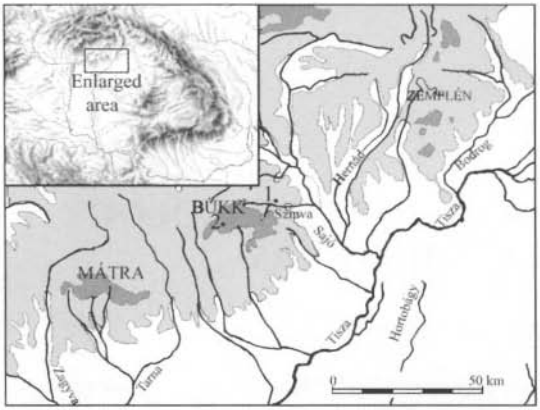

Fig. 1. Location of Szeleta Cave in the Bükk Mountains (NE Hungary)

recovered in the Hall, where the excavation reached the bedrock (Table 1). The cave fill was the thickest here (12.5 m), thinning out towards the corridors to as little as 2 m. In the Main Corridor the excavation did not reach the bedrock and did not go deeper than layer 2, thus the thickness of fill is unknown in this part of the cave. In the Side Corridor the bedrock also was exposed to some extent at the rear. The Entrance was excavated down to layer 3. The nine Pleistocene layers were not found in the same order in each part of the cave (Table 2). It is remarkable that in these early years of Paleolithic research in Hungary Kadić paid attention to features that bear information on the formation of the cave sediments. For example, Kadić recorded the type of edge-weather and the degree of weathering of lime debris and bones.

Some layers of the cave fill were further divided into sub-layers. In the case of layer 3, three hearth levels (3a, 3b, 3c) up to 0.25 m thickness, two in the Hall (3a, 3b) and one in the Side Corridor (3c), were considered. In Layer 2, two 0.2 m thick distinct horizontal debris levels in the center of the Hall were separated (Layers 2a, 2b). Stone tools from Layer 2 in the Hall were exclusively associated with debris levels 2a and 2b. Debris in Layer 2 in the Main Corridor was found scattered in the sediment.

SZELETA CAVE LITHIC INDUSTRIES

The first excavations between 1906 and 1913 removed about 2,500 cubic meters of sediment and recovered a total of about 2,000 items, including retouched tools, debitage, cores and knapping debris (Kadić, 1916; Szeleta Archives at the Hungarian National Museum). Today, 1,364 lithics can be associated authentically with the Pleistocene fill sediments (Ringer and Szolyák, 2004).

The lithic assemblages of Szeleta Cave were first classified as "Solutrean", and attributed to

Table 1

Layers of Szeleta after Kadić 1916

Layer	Color	Thickness [m]	Content
9		0.2	bat guano
8		0.2	calcareous tuff
7	black	0.7	humus
6	grey	0.5-1.0	clay, sharp stones of small size
6a, 6b	light yellow	1.0-2.0	boulders
5	reddish brown	0.2-0.5	clay, mostly sharp and a few abraded bones and stones
4	dark grey	0.5	clay, fifty percent of the bone assemblage and the stones are abraded
3	light brown	1.5-3.5	clay, three organic rich hearth horizons in Hall (3a, 3b, 3c), heavy abrasion on bones and stones and also on flint artifacts
2	dark brown	2.5-6.0	clay, two debris levels in Hall (2a, 2b), a few animal bones, mainly abraded, high phosphoric acid content
1	red	1.0	clay, similar to "terra rossa"
"creek" sediment		2.0	silt and pebbles

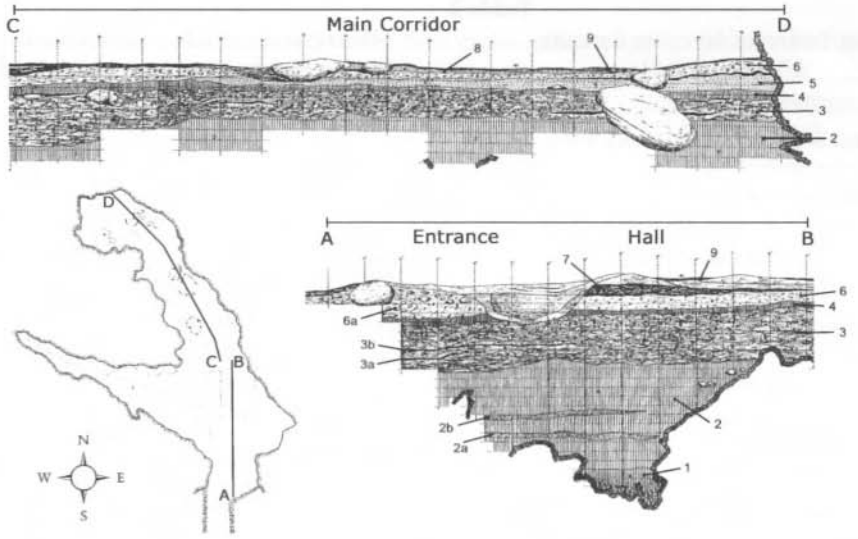

Fig. 2. Longitudinal section of Szeleta Cave, after Mottl's unpublished drawings of 1937

the Upper Paleolithic (Kadić, 1916). Kadić distinguished three types of "Solutrean": an "Early Solutrean" from Layer 3, an "Intermediate Solutrean" from Layer 4, and a "Developed Solutrean" from Layers 5, 6, 6a, and 6b. The "Early Solutrean" was characterized by rough, irregular leaf points, while the "Developed Solutrean" was characterized by fine, regular laurel leaf points. The "Intermediate Solutrean" comprised both types. This division represented a lineage between the "Early Solutrean" and the "Developed Solutrean". As Kadić claimed, the Solutrean phases of Szeleta besides the bifacial tools were characterized by other Upper Paleolithic types such as blades, burins, end-scrapers, borers, and a few backed blades and a Gravette point. The industry from Layer 2 was described as indeterminate.

After World War II, the classification for the Paleolithic occupations at Szeleta was changed. First, the Central Eastern European laurel leaf point industries were defined independent of the Solutrean, and Szeleta Cave was chosen to be the eponymous site of what is today known as the "Szeletian" (Prošek, 1953). Then new studies by Vértes attributed Layer 3 to an "Early" Szeletian, Layers 4 and 5 to an "Intermediate" Szeletian, and Layer 6 to a "Developed" Szeletian (Vértes, 1965: 138). Gábori (1964, 1990) emphasized that the "Developed" Szeletian industry without leaf points resembled the Aurignacian and, in addition, showed Gravettian influence in the presence of backed bladelets and a Gravette point. In the new classification, Layer 2 was assigned to the Middle Paleolithic Mousterian (Vértes, 1965). Except for the Intermediate Szeletian, this classification of the lithic assemblages with leaf points is still in use today.

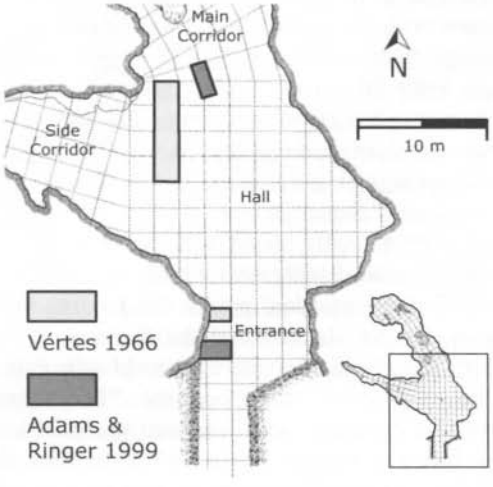

Fig. 3. Location of the excavation trenches of Vértes (1968) and Adams and Ringer (2004) in Szeleta Cave

Table 2

Distribution of layers in the cave after Kadić 1916

Layer	Entrance	Hall	Main corridor	Side corridor
9	-	-	+	+
8	-	-	+	+
7	+	+	-	-
6	+	+	+	-
6a, b	+	-	-	+
5	-	-	+	+
4	+	+	+	+
3	+	+	+	+
2	unexcavated	+	+	-
1	unexcavated	+	unexcavated	-
"creek" sediment	unexcavated	+	unexcavated	-
bedrock	unexcavated	+	unexcavated	+

Table 3

Distribution of lithic "fossil markers" in the Pleistocene stratigraphy of Szeleta after Ringer and Mester, 2000

Archaeological "fossil markers"	6	6a/b	5	4	3 upper	3 lower	2 upper
Gravettian	+	+	+	+	+		
Aurignacian	+	+	+	+	+		
Developed Szeletian	+	+	+	+			
Early Szeletian					+		
Jankovichian	+	+	+	+	+	+	+
Mousterian	+	+	+	+	+	+	+
Taubachien						+	+
Bábonyien						+	+

Concerning the "makers" of the Szeletian, Allsworth-Jones (1986) and Svoboda and Simán (1989) have claimed that the Central European Szeletian represents the product of Middle Paleolithic Neanderthals that went through an acculturation process around the Middle to Upper Paleolithic transition, explaining the presence of Upper Paleolithic types within the Szeletian as due to external influences of the Aurignacian. Svoboda and Simán (1989) argued for interaction between Neandertals and Modern Humans by highlighting the presence of an embedded Aurignacian occupation level in the upper part of the "Early" Szeletian (Layer 3c) (Svoboda and Simán, 1989: 301). In addition, Simán (1990) went deeper into the question of the evolution of the Szeletian phases, and suggested, on technological and typological grounds, that the "Early" and "Developed" Szeletian were unrelated stages. Simán (1995) finally stated that the "Developed" Szeletian indeed represents a Gravettian industry with laurel-shaped leaf points. Contrasting these views, Ringer claimed that the Szeletian is the Upper Paleolithic derivative of the Middle Paleolithic Bábonyian; therefore the "Bábonyian-Szeletian complex" was proposed to distinguish this lineage (Ringer *et al.*, 1995). Besides the Bábonyian and Szeletian, defined on the presence of "fossil markers", Ringer distinguished several other occupations, such as the Taubachian, Middle Paleolithic and even Upper Paleolithic aged Mousterian, Jankovichian, Aurignacian, and Gravettian, spanning from the Last Interglacial to the Last Glacial Maximum (Table 3) (Ringer, 1989, 1993; Ringer *et al.*, 1995; Ringer and Mester, 2000). Contrary to the interpretations outlined above, and based on comparative lithic studies of the caves of Szeleta and Istállóskő, Adams (1998) suggested that the Szeletian and the Aurignacian were the products of the same Upper Paleolithic population.

Recent reinterpretation suggests that the archeological sequence of Szeleta has been largely misunderstood. The cultural "fossil markers" distributed throughout several layers of the stratigraphic sequence at Szeleta reflect severe post-depositional disturbances and indicate that Szeleta should not be considered the type site of Szeletian lithic assemblages.

SZELETA RADIOCARBON DATES

Sampling of organic remains from the Hungarian Szeletian for radiocarbon dating began in the 1960s by Vértes (Geyh *et al.*, 1969). After Vértes, Adams and Ringer (2004) were involved with radiocarbon dating of the Szeletian. To date a total of 10 radiocarbon dates are known from Szeleta Cave (Table 4). Nine dates can be divided into two groups according to their sample prove-

Table 4

Radiocarbon dates of the Szeleta Cave. ISGS-A codes indicate application of AMS method

Lab no	14C age BP	Material	Excavation Area	Layer	Reference
GXO-197	>41,700	bone	unknown	3	Geyh *et al.* 1969
GrN-6058	43,000 ± 1100	bone	Hall	2	Vogel & Waterbolk 1972
ISGS-4464	42,960 ± 860	bone	Hall	2/3 interface	Adams & Ringer 2004
GrN-5130	32,620 ± 400	bone	Entrance	section collapse	Vogel & Waterbolk 1972
ISGS-A-0131	22,107 ± 130	bone	Entrance	section collapse	Adams & Ringer 2004
ISGS-A-0189	26,002 ± 182	charcoal	Entrance	3	Adams & Ringer 2004
ISGS-4460	>25,200	bone	Entrance	3	Adams & Ringer 2004
ISGS-A-0128	11,761 ± 62	bone	Entrance	3	Adams & Ringer 2004
ISGS-A-0129	13,885 ± 71	bone	Entrance	3	Adams & Ringer 2004
Unknown	37,260 ± 760	unknown	Entrance	3	Ringer 2002b

nances: two from the junction of the Main and Side corridors in the Hall, and seven from the trenches at the Entrance.

Among the ten dates one (> 41,700 ^{14}C BP, GXO-197) was obtained from a bone sample of unknown provenance. The only available information is that the sample was selected by Vértes from the faunal remains of Kadić's excavation and the bone was retrieved from the top of the light brown Layer 3 (Geyh *et al.*, 1969).

Dates from the Hall

In the Hall of Szeleta, Vértes took a bone sample in 1966 from the dark brown Layer 2, located just above the bedrock (Vértes, 1968: 384) and 6 meters below the original surface, resulting in an age of 43,000 ± 1,100 ^{14}C BP (GrN-6058; Vogel and Waterbolk, 1972: 62). According to Vértes this date is associated with the lowest occurrence of the "Early" Szeletian (Vogel and Waterbolk, 1972: 62).

Another sample, again on bone, was taken in 1999 at the border between Layers 2 and 3 in a trench dug parallel to that of Vértes' excavation. The sample produced the similar date of 42,960 ± 860 ^{14}C BP (ISGS-4464; Adams, 2002; Adams and Ringer, 2004; Ringer, 2002b).

Dates from the Entrance

During the 1966 excavation, Vértes observed three layers at the Entrance: a gray, a grayish brown, and a brown one, that were correlated to Layers 6, 4, and 3, respectively, of Kadić's excavations (Vértes, 1968). Vértes sampled a bone found 3 m beneath the original surface from the gray layer (claiming correspondence to Kadić's Layer 6), resulting in an age of 32,620 ± 400 ^{14}C BP (GrN-5130; Vogel and Waterbolk, 1972: 62).

At the Entrance, Adams and Ringer in 1999 continued excavating the 1966 trench of Vértes southwards. In 1999, five dates were obtained from the layers of the Entrance. In the correlation of the sampled layers to the stratigraphy of Kadić's excavation there was no complete agreement between Adams and Ringer. Of the five samples only the stratigraphic position of the first was interpreted as being in accordance. This sample, a bone, taken from 0.7 m beneath the actual surface, from a layer that was correlated with Layer 6a of Kadić, gave an AMS date of 22,107 ± 130 ^{14}C BP (ISGS-A-0131; Adams, 2002; Adams and Ringer, 2004; Ringer, 2002b). The four other dates were obtained from deeper levels of the Entrance stratigraphy. Two of these four samples, one charcoal and one bone, were taken between 2.50 and 2.60 m beneath the actual surface and provided ages of 26,002 ± 182 ^{14}C BP (ISGS-A-0189) and >25,200 ^{14}C BP (ISGS-4460), respectively (Adams, 2002; Adams and Ringer, 2004). In the first publication of these dates, Adams (2002: 53) attributed the samples to Kadić's Layer 3, while Ringer (2002b: fig 2) first correlated both samples, and then only ISGS-A-0189 (Ringer's 2nd footnote in Adams, 2002), with Layer 4. No explanation was given why Ringer altered the stratigraphic attribution of samples. In the most recent publication of Szeleta dating, Ad-

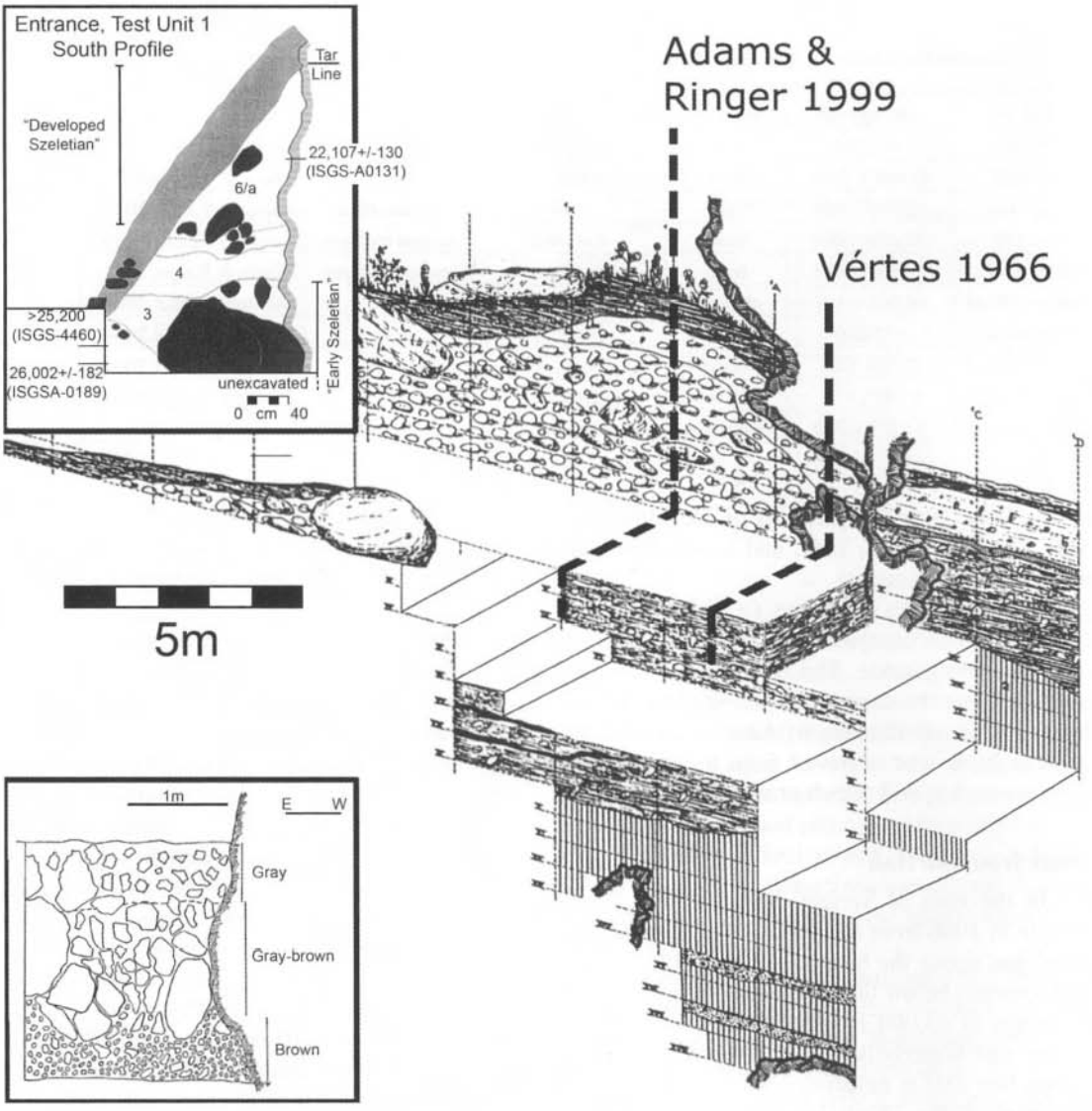

Fig. 4. Reconstruction of the state of excavations in the Entrance of Szeleta Cave before 1966 with the sections of Vértes (1968) and Adams and Ringer (2004)

ams and Ringer (2004) connected both these dates to Kadić's Layer 3. About 10 cm beneath the former samples, two bones from a thin hearth feature were dated, resulting in ages of 11,761 ± 62 ^{14}C BP (ISGS-A-0128) and 13,885 ± 71 ^{14}C BP (ISGS-A-0129; Adams, 2002). Adams (2002: 53) correlated this hearth to the "hearth" of Kadić's Layer 3b. In contrast to this, Ringer claimed that the hearth is to be attributed to Layer 3c of Kadić's excavation (Ringer's 3rd footnote in Adams, 2002), which indeed was recovered in the Hall and did not extend to the Entrance area of the cave (Ringer and Szolyák, 2004). Regardless of stratigraphic attribution, both dates are significantly younger than those from 10 cm above, which is likely due to post-depositional contamination (Adams and Ringer, 2004). From the 1999 Entrance trench, Ringer (2002b: 50) published a further date of 37,260 ± 760 ^{14}C BP from the top of Kadić's Layer 3, but unfortunately did not in-

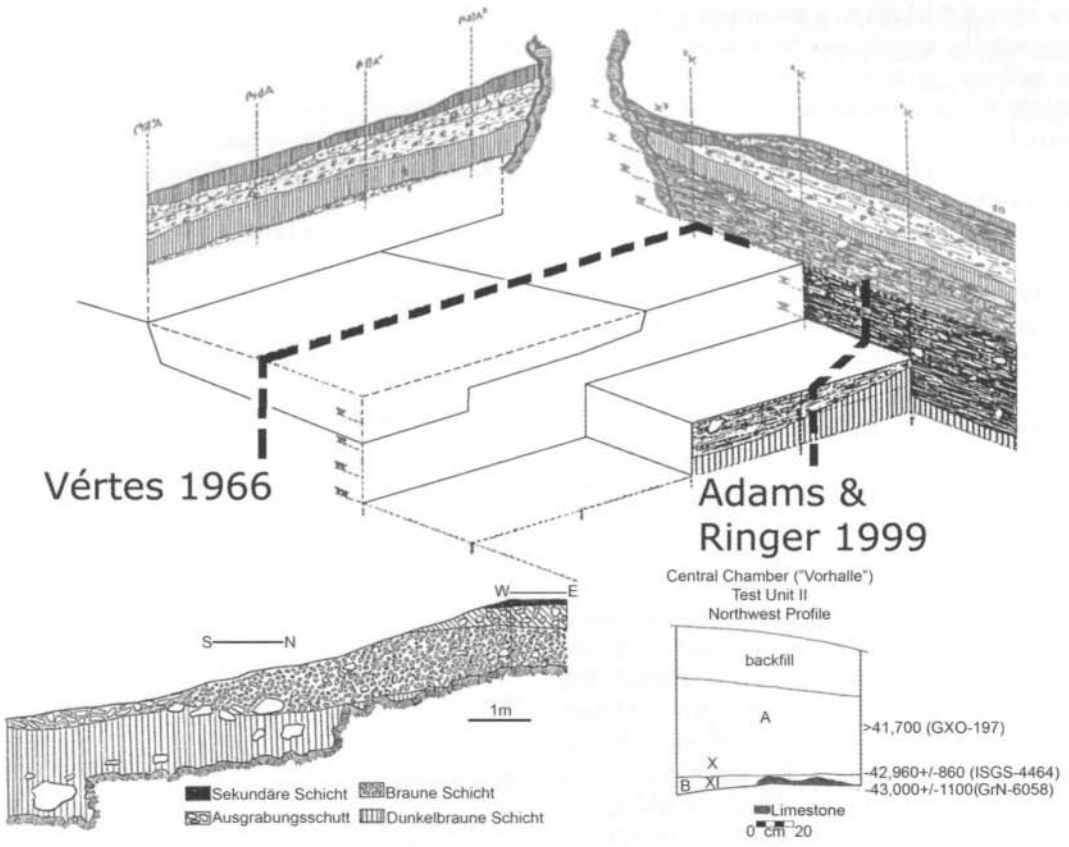

Fig. 5. Reconstruction of the state of excavations in the Hall of Szeleta Cave before 1966 with the sections of Vértes (1968) and Adams and Ringer (2004)

clude a laboratory code or any more detailed sample description.

DISCUSSION

Stratigraphic context of the dates

Layer 2

It was earlier claimed, based on petrography (Vértes, 1959: 85), that Layer 2 was formed from redeposited material of an older layer that is otherwise not preserved at the site. Decades later, based mainly on the archaeological assignment of Layer 2 and the lower part of Layer 3 to a Middle Paleolithic of Taubachian and Bábonyian types, a Last Interglacial age was assumed by Ringer (Ringer 1993: 129, 2002b; Ringer *et al.*, 1995; Ringer and Mester, 2000). If this attribution were accepted, then the great age of these layers would rule out the possibility of any radiocarbon dating and would invalidate any such date obtained from these layers. Evidence against an Oxygen Isotope Stage 5 age for Layers 2 and 3 at Szeleta include the vertebrate mammal remains of both layers within which cave bear bones dominate and other glacial species such as mammoth and reindeer are also present (Kadić 1916; Vörös, 2000: 190). This spectrum of faunal remains correlates to Oxygen Isotope Stage 4 of Suba-lyuk Cave (Mester 1994: 52, fig. 2.17.).

The single date from Layer 2, 43,000 ± 1100 ^{14}C BP (GrN-6058), came from a sample taken from the junction of the Hall and the Main Corri-

dor. Here, Layer 2 was 1 m thick, while a few meters away it thickens to a maximum of 6 meters. Although the sample was taken from just above the bedrock, it remains unknown from which stratigraphic position within Layer 2 the sample is derived.

The date of 42,960 ± 860 ^{14}C BP (ISGS-4464) lacks a clear geological context since the sample was taken from the interface of Layers 2 and 3, which is marked by a clear unconformity resulting from of a major hiatus in the stratigraphic sequence. Thus, the stratigraphic integrity of this date is to be regarded with scepticism.

Layer 3

Layer 3 appears to have suffered greatest from post-depositional disturbances. For example, all bones and limestone debris found in Layer 3 have heavily weathered surfaces. Similar abrasion can also be observed on the lithics, which appears as post-knapping abrupt pseudo-retouch. Also, the surfaces of the artifacts and the ridges between the flake scars are often weathered. The weathering of all archaeological material in Layer 3 most likely results from cryoturbation (Kadić, 1916; Allsworth-Jones, 1986), described also as "cryodeformation" (Ringer, 1988). In addition to cryoturbation, Szolyák's study of the "hearth levels" (Layer 3a, 3b, 3c) (Ringer and Szolyák, 2004) demonstrates that these hearth features extended horizontally up to several meters and were most likely due to ancient water flow in the cave. The post-depositional disturbance of this layer is also evidenced by the chronometric range and reversed sequence of dates in the Entrance trench. It is thus clear that sampling "in situ" material from Layer 3 for radiocarbon dating is and was impossible.

Uncertain geological context

The stratigraphic integrity of two dates from the Entrance, 32,620 ± 400 ^{14}C BP (GrN-5130) from Vértes' excavation and 22,107 ± 130 ^{14}C BP (ISGS-A-0131) from the excavation of Adams and Ringer, cannot be assumed. Reconstruction of the location and the volume of the excavated areas (Figs 3–5) in the Entrance indicates that the area between the cave mouth and the valley slope was last excavated in 1913 (Mester, 2002: 70, Fig. 16). The excavations in 1906–1913 removed the upper 2 m of the cave fill (Levels I–IV) and stopped at the top of Layer 3. The location of the 1966 and 1999 Entrance trenches falls exactly within this excavated area. Thus, their stratigraphy should start here in Kadić's Layer 3, without any overlying layers being evident. Nevertheless, the 1966 and 1999 sections reveal layers containing large limestone blocks above Layer 3. It is known from Mottl (1945: 1553) that the sections of Kadić's excavations at the Entrance were collapsed to the extent that they could not be correlated with the original drawings. Since this area was not exposed again, and Vértes emphasized in his report the lack of a fine sediment fraction among the stones but did not recognize that this was due to the recent infilling of the area, the upper members of the 1966 and 1999 excavations must represent part of the sections that collapsed sometime between 1913 and the 1960s. Consequently, the dates of 32,620 ± 400 ^{14}C BP (GrN-5130) and 22,107 ± 130 ^{14}C BP (ISGS-A-0131) most likely derive from mixed stratigraphic material dating to disparate periods.

Archaeological context of the dates

Almost all of the dates discussed here lack clear archaeological contexts. For example, Vértes did not find any lithics in the sampled layers during his 1966 excavation (Vértes, 1968: 382–383), and the archaeological material from the 1999 excavation, except one obsidian bladelet core found 20 cm above the sample dated to 26.0 ka ^{14}C BP (ISGS-A-0189; Adams, 2007: 65), remains unpublished.

One date linked to archaeological material, GXO-197 (> 41,700 ^{14}C BP), was obtained from a sample of Kadić's excavation of the upper part of Layer 3. Unfortunately, this date, as mentioned above, has no relevant provenance, and thus could be associated with any part of the cave where Layer 3 was observed and with any artifacts found within this layer. Previously, all lithics from Layer 3 were associated with the "Early" Szeletian (Vértes, 1965; Allsworth-Jones, 1986), and then with the "Early" Szeletian and Aurignacian (Svoboda and Simán 1989). Since Ringer's recent review of the lithic artifacts from Kadić's Layer 3 highlights the presence of several "fossil

markers" (Ringer, 2002a, b; Ringer and Mester, 2000), the GXO-197 date (> 41,700 ^{14}C BP) could be linked with Mousterian, Jankovichian, "Early" Szeletian, Gravettian, and Aurignacian artifacts.

The sample from Layer 3 dated to 26.0 ka ^{14}C BP date (ISGS-A-0189) by Adams and Ringer was found in close association with the published obsidian bladelet core. The use of obsidian for laminar production in the territory of Hungary appeared first in the Early Gravettian context of Bodrogkeresztúr-Henye, located in northeastern Hungarian Zemplén Mountains, and has been dated to ca. 28.0 ka ^{14}C BP (Dobosi, 2000). Therefore the association of an obsidian bladelet core with Mousterian type implements (Szeletian and Jankovichian leaf points) in Layer 3 must, as shown by Ringer, result from mixing between these and Gravettian lithic assemblages.

Admixture of different types of lithic tools is not exceptional to Layer 3. Each dated layer contains a mixture of remains from at least four Paleolithic cultural entities (Table 3). Although Ringer and Mester (2000) claim the contemporaneous and/or alternate presence of several Upper and Middle Paleolithic cultural entities in Szeleta, the taphonomy of the lithics, including refittings between Layers 4 and 6a in the Entrance by one of us (Zs. M.) (Ringer and Mester, 2000: 266) imply that archaeological cultural interstratifications are best explained by post-depositional disturbances that vertically displaced artifacts between layers (e.g., Bordes, 2003; Villa, 1982). These data emphasize the fact that none of the dated samples are derived from secure, in situ archaeological contexts.

CONCLUSION

At Szeleta Cave, evidence for the presence of several Paleolithic "fossil markers" within a single layer indicates extensive stratigraphic displacement of artifacts over thousands of years. The agency of displacement in the cave, as yet unknown, also displaced organic remains that were used for radiocarbon dating, as evidenced for instance by the wide range of dates from > 41,700 to ca. 11,000 ^{14}C BP within Layer 3. In such a case, it is impossible to assign dates to specific archeological entities.

Uncertain correlations between layers excavated recently and those exposed by Kadić are also of significance. Such uncertainties are best represented by the 1999 excavation, during which the excavators could not agree how to correlate the samples taken for ^{14}C dating with Kadić's original stratigraphy.

Based on the apparent mixture of both organic and lithic remains, and serious uncertainties in linking ^{14}C dates to geological and especially archeological units, none of the radiocarbon dates can be securely associated with any occupation of the cave. Taking also into account the rigorous requirements for taking and selecting samples for ^{14}C dating (Waterbolk, 1971; Pettitt *et al.*, 2003; Vermeersch, 2005), we claim that at present the absolute chronological position of the Szeletian in Hungary remains unknown.

Acknowledgments

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