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Archaeological sites of the Süttő Travertine Complex (Hungary) with stratigraphical and paleoecological implications from their faunas

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Abstract

The Süttő Travertine Complex in northern Hungary is known in the geological literature for more than a century as a series of paleontological sites. This site is one of the largest travertine occurrences of the Gerecse Hills. Loose Upper Pleistocene eolian sediments (mainly Riss-Würmian loess and Holocene topsoil) cover the eroded surface of the travertine. Beside vertebrate assemblages, two archaeological sites were described from this area. One of them (Süttő-Diósárok) was a Paleolithic fire pit situated in the road cut between Süttő and the quarries, while the other one was discovered in a fissure of the northern wall of Diósvölgy Quarry. The latter is part of the so called Süttő 1 vertebrate site.

Vértes (1965) referred the artifacts from Süttő-Diósárok to the Moustérian (Tata Culture). This site is referred here to MIS 5c, based on the vertebrate and snail faunas representing warm and dry climate, and steppe-like vegetation, as well as on the tool-bearing dark brown chernozem-like paleosoil layer of the loess-paleosoil sequence, with a luminescence age of 93.7±21.1 ka.

Artificially fractured bones were excavated from the small cavity of Süttő 1. Some of those remains displays toolmarks. Unfortunately, these elaborated bones are currently missing from the collection. According to Vértes (1965), the latter artifactsmost likely belong to a level, which pre-dates the Tata Culture. Paleoecological inferences of the present paper based on the mammalian and mollusc faunas indicated warm, humid climate and forest vegetation, therefore suggest a a stratigraphic correlation of Süttő 1 with the Eemian interglacial (MIS 5e).

Keywords

Moustérian (MIS 5c), Eemian (MIS 5e), archaeology, mammals, molluscs, paleoecology

1. Introduction

The Süttő Travertine Complex (northern Hungary) is known in the geological literature for more than a century as a series of paleontological sites. The age of this complex was discussed by several authors since the middle of the 19th century (Hantken, 1861; Hauer, 1870; Hofmann, 1884; Liffa, 1907; Kormos, 1911, 1913, 1926; Fleissig & Kormos, 1934; Schréter, 1953; Scheuer & Schweitzer, 1974; Jánossy, 1969, 1979; Brunnacker et al., 1980; Jánossy & Krolopp, 1981; Novothny et al., 2009, 2011; Kele, 2009; Sierralta et al., 2010).

According to our knowledge, it was Kormos (1926) who first identified vertebrate remains from the travertine and from the fissures therein. His observation, that the age of the vertebrates from the travertine is much older than the age of the fissure-infilling faunas, was a good basis for later research. Although vertebrates were found at Süttő even directly in travertine sediments and in a loess-paleosoil sequence (Süttő 6), most of the remains were come from the fissures. In addition to these assemblages, two archaeological sites were described from the Süttő Travertine Complex (Fleissig & Kormos, 1934).

In 1926, Kormos and Kubacska were found human traces at Süttő (Kormos, 1926; Fleissig & Kormos, 1934) for the first time. In 1932, Fleissig and Kormos were excavated at this place (Fleissig & Kormos, 1934) and were found a Palaeolithic fire pit in the road cut between Süttő and the travertine quarries. This site was named to Süttő-Diósárok. Another archaeological site was discovered on the northern wall of the Diósvölgyi quarry, at the site Süttő 1, which was a shorter, lengthwise fissure, which downwards widening to a cavity. In addition to the archaeological material, fossil plant remains, mammals and molluscs were found in both localities.

The travertine and the covering loess-paleosoil sequence have been physically dated in recent years. Uranium-series (^{230}Th/^{234}U) dating of the travertine formation at Süttő gave ages between 314 ± 45 ka and 235 ± 21 ka (Sierralta et al., 2010), which corresponds to Marine Isotope Stages (MIS) 7–9. However, even Pliocene fossils (*Anancus arvernensis, Tapirus arvernensis*) were found in at least two travertine quarries at Süttő (Pazonyi et al., in press). The formation of the overlying loess-paleosoil sequence was dated by OSL to MIS 2–6 (Novothny et al. 2009, 2011).

Present study gives an overview on the current knowledge about the two archaeological sites from Süttő. In addition, similarity studies and paleoecological analyses based on mammalian and mollusc faunas were performed in order to provide further arguments for the stratigraphical positions and paleoecology of the above mentioned sites.

2. Geological setting

The town of Süttő is located in northern Hungary, about 60 km northwest of Budapest, close to the right bank of the river Danube (47º44.26’ N, 18º26.87’ E). The vertebrate sites at Süttő occur in the Diósvölgy, Hegyhát, Új Haraszt, and Pachl Quarries, all located on the northern slope of the Haraszt Hill in the Gerecse Hills, part of the West Hungarian Mountain Range (Fig. 1).

The Süttő Travertine Complex is one of the largest travertine occurrences in the Gerecse Hills covering an area of more than 1 km^2. The immediate bedrock of the travertine is a series of Upper Pannonian gravel, sand, and clay, which was correlated by Pécsi et al. (1982) with the VIIth terrace of the river Danube. The minimum age of this terrace is Late Pliocene based on records of *Anancus arvernensis* and *Tapirus arvernensis*, which were found in the overlying travertine cover (Jánossy & Krolopp, 1981). Loose Upper Pleistocene eolian sediments (namely Riss-Würmian loess and Holocene top-soil) cover the eroded surface of the travertine. A reddish paleosoil horizon was found in the lower part of the loess section, which developed during the last interglacial (Pécsi et al., 1982; Novothny et al., 2009, 2011).

3. Material and methods
3.1. Archaeological sites of Süttő
3.1.1. Süttő-Diósárok

Süttő-Diósárok is a Palaeolithic fire pit (3–4 m in length) which was unearthed in the road cut between Süttő and the quarries. It was found in a 5–8 m high loess profile of the eastern side of the road cut, about 4 m below the surface. The red burned loess was 10–15 cm thick at its thickest part and included abundant charcoal and bone fragments. Most of the charcoal remains belong to larch/spruce (*Larix* sp. or *Picea* sp., 107 pieces), but four remains of *Pinus* sp. were also found, two of which probably belong to *P. cembra* (Vértes, 1965). A typical loess mollusc fauna (Table 1) was found in the surroundings of the site (Fleissig & Kormos, 1934), but since it was not collected bed-by-bed its stratigraphical position is unclear.

All silex flakes were produced from gravels of the Danube (mainly grey or reddish brown firestones and jaspers). However, only few of them were processed. The artifacts interpreted as blades, end-scrapers and borers were referred to the Magdalenian (Fleissig & Kormos, 1934).

3.1.2. Süttő 1

Another archaeological site was found on the northern wall of Diósvölgyi quarry, at the site Süttő 1, a short, lengthwise fissure, which was downwards widened to a cavity. Artificial fractured bones (bones and teeth of *Cervus elaphus*, cervids and bovines, teeth of *Ursus arctos* and remains of *Testudo suttoensis*) were excavated from this small cavity. Toolmarks are present on a part of these bone fragments. A 5–6 cm thick reddish brown burned horizon in the lowest layer of the cavity containing charcoal fragments and black burned bones was recognized as a trace of a Palaeolithic fire pit.

From the layer of the fire pit, in addition to the bear teeth and the turtle shells also long bone fragments of large ruminants were found. According to their shape, some of them were probably used as tools or weapons (Fleissig & Kormos, 1934). Moreover, on six specimens toolmarks made by humans were recognized.

3.2. Methods

3.2.1. Similarity study

For the comparison of the faunal assemblages we calculated correlation values. Faunal correspondences can be demonstrated using percentage similarity, which is an index that measures the common part of two temporally consecutive or spatially adjacent communities. Percentage similarity is calculated according to Krebs (1989):

$$P = \Sigma \text{ minimum } (p_{1i}, p_{2i});$$

where P is the percentage similarity between community 1 and community 2, p_{1i} is percentage of the i^{th} species of community 1, and p_{2i} is percentage of the i^{th} species of community 2.

3.2.2. Paleoecological analysis

Paleoecological analysis of the mammalian and mollusc faunas of the archaeological sites was based on grouping of that species which require particular climatic and environmental conditions. In the case of mammals, we distinguished between steppe and forest species, while in the case of molluscs we grouped xerophilous, hygrophilous, oligotherm and thermophilous species. Based on the percentage of each group within a fauna, we inferred the paleoclimatic and paleoenvironmental conditions (Pazonyi et al., in press).

4. Results

4.1. Süttő-Diósárok

Unfortunately, no sufficient number of vertebrate remains is currently available from Süttő-Diósárok for a similarity study and a paleoecological analysis. Moreover, the detailed stratigraphical position of the mollusc faunas, which were collected from the surroundings of the site, are unclear. Presumably, they represent parts of MIS 2 (30,000–14,500 cal yr BP) (Vértes, 1965), but the remains were not collected bed-by-bed. However, the composition of the flora (*Larix* vel *Picea* sp., *Pinus* sp., *Pinus cembra*) does not refer to this period, since it indicates less continental conditions (Vértes, 1965). The stratigraphical position of this site can not be determined on the basis of the molluscs and plants, results of the archeological studies were determined this issue only.

4.2. Süttő 1

The similarity study of the small mammal fauna of Süttő 1 showed the highest similarity (61.6%) among the faunas of the Süttő Travertine Complex with that from Süttő 7/L. In fact, this assemblage only similar to Süttő 7/L, because values of similarity with the other faunas are under 50%. Such values show, that these faunas differs from Süttő 1. The similarity between the faunas of Süttő 1 and 7/L is moderate, compared with similarity values between other faunas of the Carpathian Basin in the 130–100 ka period (Pazonyi, 2011).

Both faunas were dominated by forest species, mainly by *Apodemus sylvaticus*. The relative proportion of steppe species, mainly that of *Microtus arvalis*, was similarly high in both assemblages. The mollusc faunas of both from Süttő 1 and 7/L were dominated by hygrophilous (*Vallonia costata*, *Clausilia dubia*) and thermophilous (*Laciniaria plicata*, *Cepaea vindobonensis*) species, Nevertheless, the percentage of xerophilous species (e,g,, *Granaria frumentum*) was also high (Table 2).

The paleoecological investigations of both sites indicate warm, humid climate and mainly forest vegetation, but the relatively high proportion of mammal and mollusc species preferring dry and open areas indicates that the entire surroundings probably were not covered by forest vegetation. Relative proportions of the forest and open area-preferring mammals (53.4% and 27.7%), are in agreement with the "ecological unit 3's" of Pazonyi (2011). This ecological unit was characterized by mainly a woody scrub vegetation. The "ecological unit 3" represents interglacial periods (Pazonyi, 2011).

Since Süttő 7/L is dated with cerain probability to MIS 5e (Pazonyi et al., in press), most plausibely Süttő 1 has to be correlated with the Eemian interglacial too(Fig. 4). This result confirms the assumption of Vértes (1965).

5. Discussion

5.1. Süttő-Diósárok

In the opinion of Fleissig and Kormos (1934), the archaeological material of this site belongs to the Magdalenian. However, according to later studies of Vértes (1965) none of the ten silex flakes from this site, stored in the collection of the Hungarian National Museum, is a typical Upper Palaeolithic tool, but they rather comparable to the tools from Tata. Vértes (1965) considered the artifacts (some of which are shown in Fig. 2) from Süttő-Diósárok belonging to the Moustérian.

Tata is an important middle Moustérian site located also in a travertine quarry about 15 km southwest of Süttő. The archaeological material was found in a thin loess layer, embedded in the travertine. The age of the site is correlated with the Brørup interstadial (MIS 5c), and its palaeoclimatic conditions were described as warm and dry (Vértes, 1965). Based on uranium-series dates, the age of the site is ~100 ka BP (Schwarcz & Skoflek, 1982).

These data are in agreement with the OSL age of 93.7±21.1 ka (corresponding to MIS 5c)of a dark brown chernozem-like paleosoil layer in the covering loess-paleosoil sequence of Süttő (Novothny et al., 2011). Based on the results of Novothny et al. (2011) soil micromorphology provides a good marker of a warm, but dry climate with steppe-like vegetation.

It is possible, that the tools described from Süttő-Diósárok also can be originated from a layer in the covering loess-paleosoil sequence and thus have Moustérian age. Since the amount of the mammal and mollusc remains was not sufficient to our similarity and paleoecological studies, the aforementioned question can be solved only by new systematic excavations (Fig. 4).

5.2. Süttő 1

Fleissig and Kormos, the diggers of Süttő 1, estimated the archaeological material (charcoals, elaborated bones and burned clay nodules) belonging to the Chelles Culture of the Lower Palaeolithic (Fleissig & Kormos, 1934). Unfortunately, later the elaborated bones got lost and consequently this site was cancelled from the list of Hungarian archaeological localities. According to Vértes (1965), the artifacts are probably pre-dates the Tata Culture.

Jánossy and Krolopp (1981) assumed that Kormos collected the fauna of Süttő 1 from two different places, but in the present study, since the mammal and mollusc assemblages didn't contain stratigraphically and paleoecologically incongruous species, they were judged as probably not mixed. The composition of the vertebrate fauna, especially the occurrence of *Testudo suttoensis,* indicates a warmer climate than at the Süttő-Diósárok site.

The results here verified these former assumptions. On the basis of similarity study, the mammalian assemblage of Süttő 1 is similar to the fauna of Süttő 7/L. The latter was dated to the Eemian (MIS 5e). The paleoecological investigations indicate warm, humid climate and mainly woody scrub vegetation. This type of vegetation is typical for the interglacial periods in the Carpathian Basin.

Conclusion

Although the material of the archaeological sites of Süttő is scarce and the archaeological findings of Süttő 1 are missing, the stratigraphical positions of both sites can be determined with more or less confidence by utilization of archaeological, plant, mammal and mollusc remains, as well as the former pedological and paleontological investigations and physical dating of the Süttő Travertine Complex.

Present study was not able to clearly identify the exact stratigraphical position of the Süttő-Diósárok site, since the vertebrate material was not sufficient for similarity studies and paleoecological analyses. All the same, mainly on the basis of the atrifacts, plants and our former results (Pazonyi el al., in press), this site probably corresponds with MIS 5c. However, this assumption can be only confirmed by new systematic archaeological excavations.

In the case of Süttő 1, the results verified the former assumptions of Vértes. Paleoecological studies indicated interglacial vegetation and climate, while the similarity study proved the correlation with the Eemian (MIS 5e).

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Figure caption

Fig. 1. Map showing the geographic position of Süttő in northern Hungary (Novothny et al., 2011) (left side), and the quarries of Süttő (numbered) with vertebrate localities (right side). Asterisks indicate the archaeological sites (Süttő-Diósárok, Süttő 1).

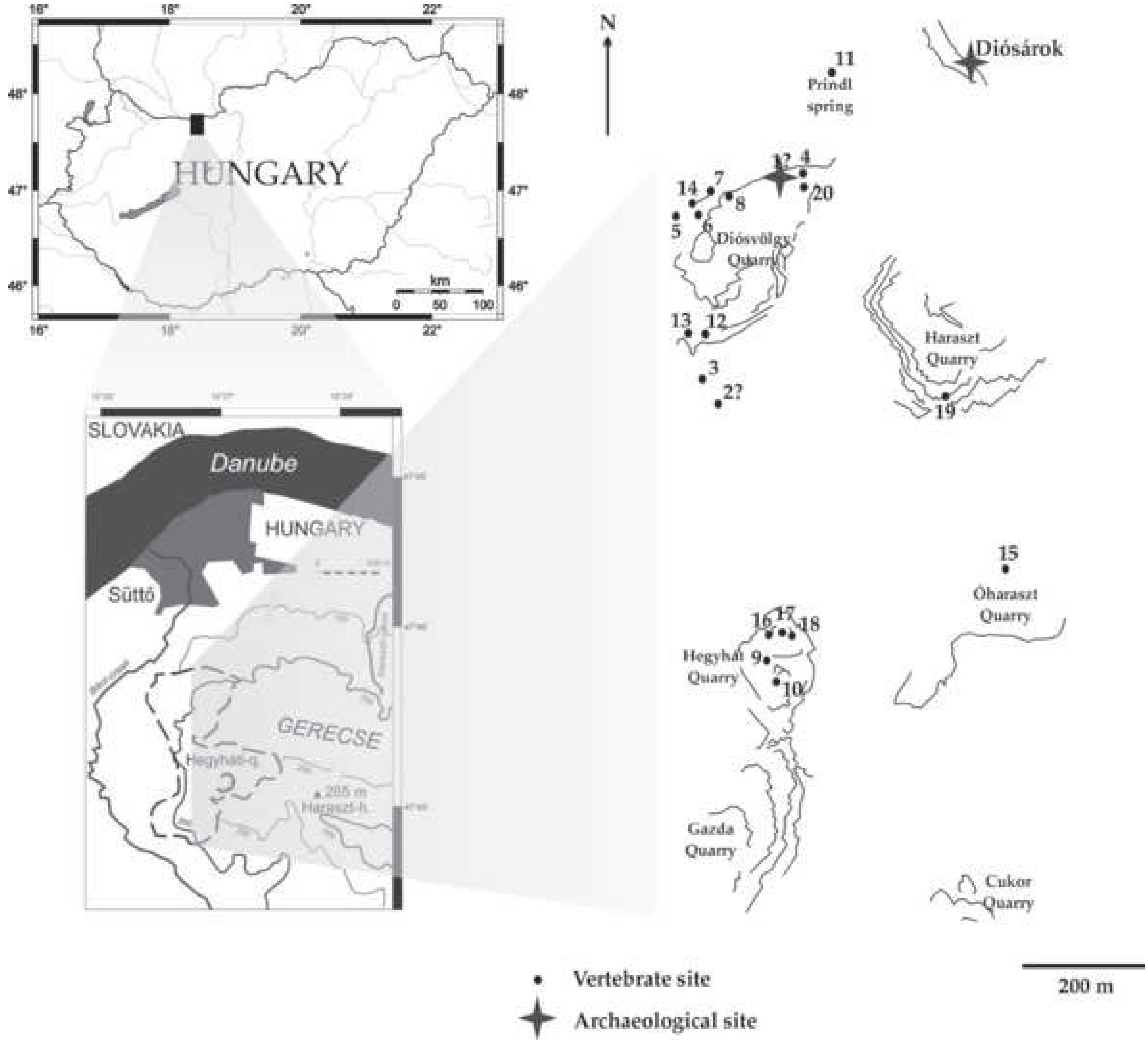
Fig. 2. Artifacts from Süttő-Diósárok and Süttő 1. **A.** Original figures of the artifacts from Süttő-Diósárok by Fleissig and Kormos (1934). **B.** Artifacts of Süttő-Diósárok from the collection of the Hungarian National Museum (photos by A. Markó).

Fig. 3. Stratigraphical positions of vertebrate and archaeological sites of Süttő.

Table 1. Plants, vertebrates and molluscs from Süttő 1 and Süttő-Diósárok sites.

Table 2. Results of the paleoecological analysis of vertebrate and archaeological sites of the Süttő Travertine Complex.

Figure 1


16°
18°
20°
22°
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47°
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HUNGARY
km
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SLOVAKIA
Danube
HUNGARY
Süttő
GERECSE
Hegyhát-q.
205 m
Haraszt-h.
N
11
Prindl spring
Diósárok
14
7
8
12
4
20
5
6
Diósvölgy Quarry
13
12
3
22
Haraszt Quarry
19
15
Óharaszt Quarry
16
17
18
9
10
Hegyhát Quarry
Gazda Quarry
Cukor Quarry
Vertebrate site
Archaeological site
200 m

Figure 2
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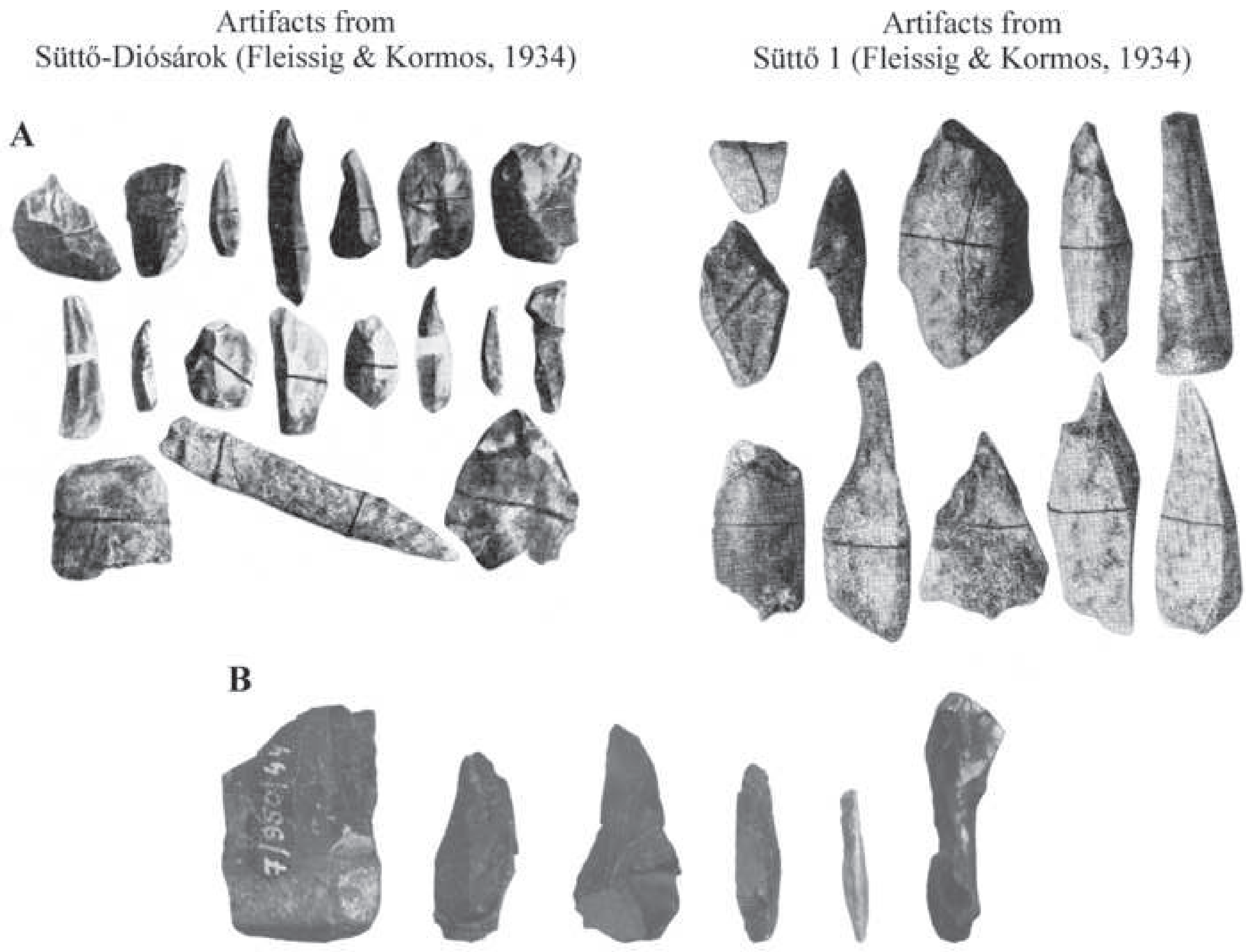

Figure 3
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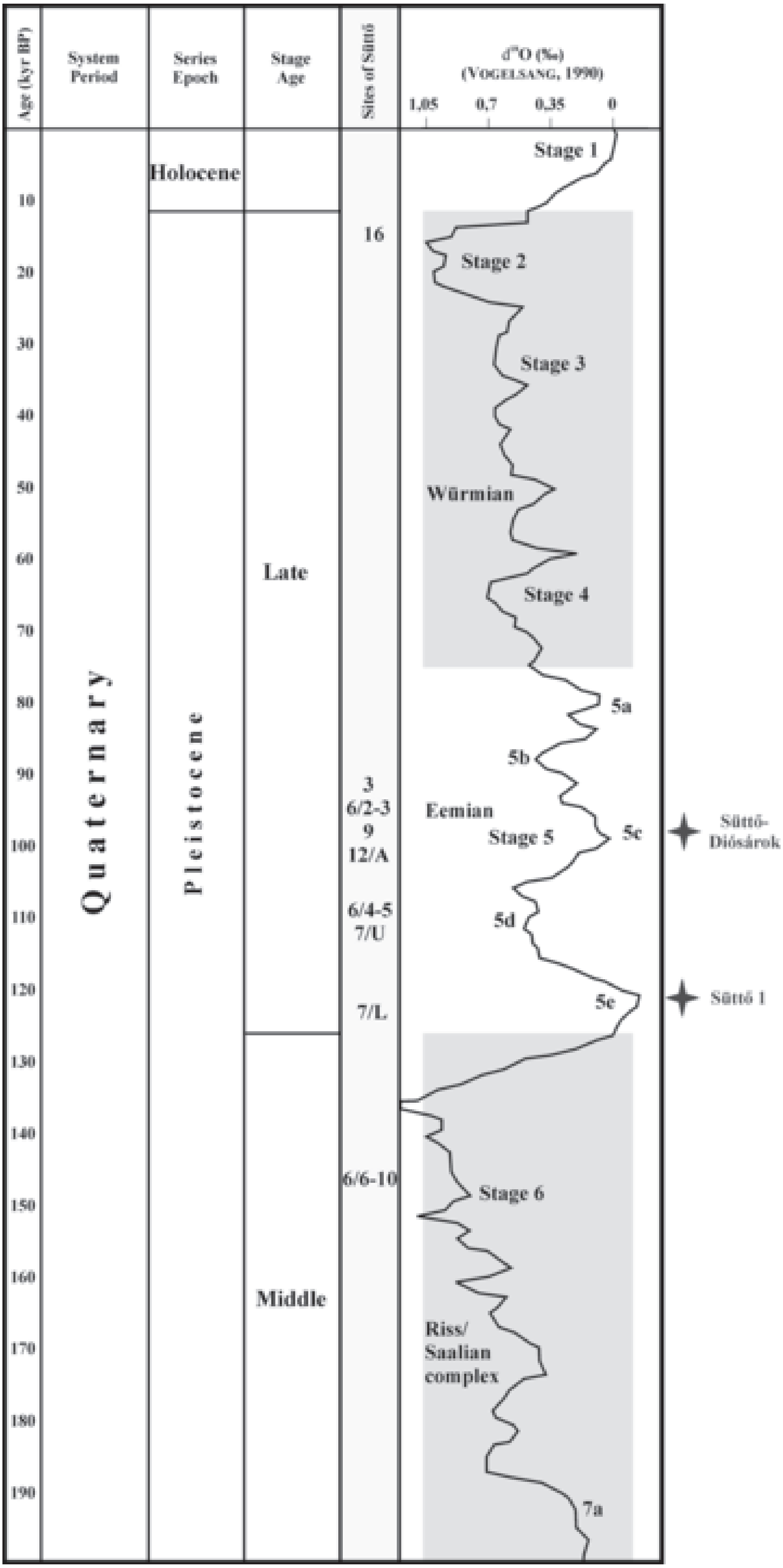

Table 1

	Süttő 1	Süttő-Diósárok
plants		
Larix vel *Picea* sp.		107
Pinus sp.		2
Pinus cembra		2
Celtis australis	*	
mammals		
Talpa europaea	2	
Crocidura leucodon	1	
Crocidura suaveolens	1	
Crocidura sp.	1	
Canis lupus	1	
Vulpes vulpes	1	
Felis leo	1	
Hyaena (?*crocuta*)	1	
Glis glis	3	
Apodemus sylvaticus	17	
Pitymys subterraneus	1	
Microtus arvalis	15	
Cervus elaphus	8	
Capreolus capreolus	1	
Bovidae indet.	1	
Equus caballus	1	
Sus scrofa	1	
molluscs		
Carychium minimum	24	
Orcula doliolum	20	
Pupilla muscorum	12	**
Granaria frumentum	20	***
Vertigo pusilla	20	
Truncatellina minutissima	25	
Chondrula tridens	2	
Acanthinula aculeata	2	
Vallonia pulchella	70	*
Succinea oblonga		***
Trichia hispida		***
Clausilia laminata	30	
Clausilia plicata	32	
Clausilia plicatula	34	*
Clausilia dubia	10	
Clausilia dubia obsoleta	104	
Clausilia dubia vindobonensis	7	
Clausilia pumila	8	
Clausilia ventricosa	3	*
Cochlicopa lubrica	4	
Aegopis verticillus	15	
Oxychilus cellarius	50	*
Aegopina nitens	3	
Aegopina nitidula	1	
Retinella hiulca	2	

Vitrea crystallina	2	
Vitrea subrimata	6	
Hyalinia (Vitrea) opinata	2	
Phenacolimax pellucidus	4	
Discus rotundatus	40	
Discus ruderatus	2	
Arianta arbustorum		***
Martha sp.	5	
Euomphalia strigella	2	
Monacha incarnata	24	
Trochulus unidentatus	1	
Helicodonta obvoluta	24	
Soosia diodonta	10	
Cepaea vindobonensis	60	
Helix pomatia	3	

Table 2

	loess		fissures of travertine						archaeological sites	
	Süttő 6/2-3	**Süttő 6/4-5**	**Süttő 3**	**Süttő 7/L**	**Süttő 7/U**	**Süttő 9**	**Süttő 12/A**	**Süttő 12/B**	**Süttő 1**	**Süttő-Diósárok**
mammals										
Sicista cf. *subtilis*	1.69	5.13		1.85	4.17					
Spalax cf. *leucodon*	2.54			1.23		4.55	3.08	7.41		
Cricetus cricetus						6.82				
Cricetulus sp.							1.54			
Spermophilus citelloides	8.47	7.69		1.23	8.33					
Microtus arvalis	48.31	43.59	40	11.69	20.83	36.36	16.92	7.41	26.32	
Equus sp.						2.27			1.75	
Bos sive *Bison*				0.31		3.41				
steppe species (%)	**61.02**	**56.41**	**40**	**16.31**	**33.34**	**53.42**	**21.54**	**14.82**	**28.07**	
Crocidura leucodon group		2.56		0.62		3.41	7.69	3.70	1.75	
Crocidura cf. *suaveolens*	0.85		5					22.22	1.75	
Crocidura sp.									1.75	
Glis glis	1.69	2.56		5.85			1.54		5.26	
Dryomys nitedula	0.85			0.31						
Mus sp.	0.85					1.14				
Mus cf. *musculus*				0.92						
Apodemus sylvaticus	11.02	15.38	25	32.92	20.83	2.27	13.85	22.22	29.82	
Myodes glareolus	5.08	12.82	15	17.85	4.17	6.82	3.08	3.70		
Ursus arctos				0.31						
Vulpes vulpes									1.75	
Cervus elaphus									14.04	
Capreolus capreolus				1.54					1.75	
Dama sp.	0.85		15	0.92						
Sus scrofa				0.62					1.75	
forest species (%)	**21.19**	**33.33**	**60**	**61.85**	**25**	**13.64**	**26.15**	**51.85**	**59.65**	
molluscs										
Chondrula tridens	1.07	1.06							0.29	
Cochlicopa lubrica		0.18			0.87	0.2	0.20		0.59	*
Granaria frumentum	16.37	21.20		15.42	2.62	12.75	8.08	5.65	2.93	***
Pupilla triplicata	0.64	1.77		3.75	0.44	0.59	5.05	4.84		
Chondrula tridens			60.94		0.44	23.57	4.44	4.03		
Euconulus fulvus		3.53				0.05	0.20			
Helicopsis striata			37.5		0.87	19.19	14.55	9.27		
xerophilous species (%)	**18.09**	**27.74**	**98.44**	**19.17**	**5.24**	**56.35**	**32.53**	**23.79**	**3.81**	********
Vallonia costata	2.74	6.71		27.08	3.93	12.06	7.07	10.08		
Clausilia dubia	0.05	3.36		0.42	1.75	1.08	0.20		1.46	*
Clausilia pumila	3.11	1.24		0.42	10.92	0.1			1.17	
Discus ruderatus	0.05				4.37	1.38			0.29	
Nesovitrea hammonis				0.42	0.44	0.89				
Arianta arbustorum						0.39	0.20			***
hygrophilous species (%)	**5.96**	**11.31**	**0**	**28.33**	**21.4**	**15.9**	**7.47**	**10.08**	**2.93**	********
Succinea oblonga		16.96				1.43	0.20	1.21		***

	loess		fissures of travertine						archaeological sites	
	Süttő 6/2-3	**Süttő 6/4-5**	**Süttő 3**	**Süttő 7/L**	**Süttő 7/U**	**Süttő 9**	**Süttő 12/A**	**Süttő 12/B**	**Süttő 1**	**Süttő-Diósárok**
Pupilla sterri		0.53				0.34	2.22	5.24		
Pupilla muscorum		2.65			0.44	1.23	1.41	0.40	1.76	**
Vallonia tenuilabris		15.90		1.25	30.57	0.59	2.22	4.44		
Trichia hispida		2.65			0.87	2.85				***
Trichia striolata		1.41					0.20	0.40		
oligotherm species (%)	**0**	**40.11**	**0**	**1.25**	**31.88**	**6.45**	**6.26**	**11.69**	**1.76**	********
Acanthinula aculeata							0.40	0.40	0.29	
Laciniaria plicata	3.22	0.71		4.17	6.55	0.05			4.69	
Aegopis verticillus									2.2	
Aegopinella minor	0.11	0.71		1.25	1.75	0.05	1.82	2.82		
Phenacolimax annularis	0.11	0.35		1.67		2.21	1.41	0.81		
Soosia diodonta							0.40		1.46	
Cepaea vindobonensis	1.50	1.24	1.56	0.42		0.84	1.21	0.81	8.78	
thermophilous species (%)	**4.94**	**3**	**1.56**	**7.5**	**8.3**	**3.15**	**5.25**	**4.84**	**17.42**	