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Aspects of the geology, palaeontology and archaeology of the travertine site of Weimar-Ehringsdorf (Thuringia, Central Germany)

With 4 figs

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Abstract

The Pleistocene travertine site at Weimar-Ehringsdorf has been the subject of controversial discussions for many years. Eleven levels with microvertebrates (Amphibia, Reptiles, Mammals) have been distinguished within the travertine sequence. The material provides information about repeated climatic changes. The evolutionary level of several mammals (e.g., *Castor, Arvicola, Equus, Stephanorhinus, Megaloceros, Cyrnaonyx*) as well as the occurrence of *Apodemus maastrichtiensis* suggest that the Lower Travertine belongs to an intra Saalian warm period. An attribute analysis of artefacts from the Lower Travertine shows closest similarities to early Weichselian and Eemian inventories. Indeed, a possible pre-dating of the Rheindahlen complexes R1 and B3 gives indications of a more complex content within the configuration achieved by technical archaeological studies.

Key words: Middle Pleistocene, Upper Pleistocene, travertine, microvertebrates, large mammals, archaeology

Introduction

The travertine site at Weimar-Ehringsdorf, located in the Ilm Valley Graben, Thuringia, is one of the most important Pleistocene localities in Central Europe. The locality has yielded an abundance of plant and faunal remains, among them a diverse vertebrate assemblage, including fish, amphibians, reptiles, birds, and mammals (H.-D. Kahlke 1974, 1975a). Human remains and Palaeolithic artefacts have also been recovered (e.g., Behm-Blancke 1960, Vlček 1993). The standard geological profile of the site (Lower Travertine, Pariser Horizon, Upper Travertine I, Pseudopariser, Upper Travertine II), established in the first half of the last century (Soergel e.g., 1926, 1940) has become the main reference for many finds since that time. There is evidence, however, that the stratigraphical subdivision of the travertine sequence is, in fact, more complicated than Soergel's standard profile suggests. Field research in the 1970s resulted in a new standard profile for the travertine sequence at Weimar-Ehringsdorf (Steiner, e.g., 1973, 1974, 1979, Wagenbreth & Steiner 1974), indicating that the Upper Travertine consists of four distinct travertine beds (Upper Travertine A to D) separated from one another by three Pseudopariser layers (Pseudopariser I to III). Even the age of Weimar-Ehringsdorf has been the subject of much discussion for many years. Some authors (e.g., Wüst 1909, 1910, Behm-Blancke 1961, Mania 1973) considered the whole travertine sequence to be Eemian, whereas others equated only the Lower Travertine with the Eemian, but the Pariser Horizon, the Upper Travertines and the Pseudopariser with the Weichselian (e.g., Soergel 1926, H.-D. Kahlke 1975b). However, there is increasing evidence that the travertine deposits at Weimar-Ehringsdorf belong to an intra-Saalian warm period (e.g., Eisenmann 1991, Mania 1997, Heinrich 2003, van der Made 2003). In the following paper some data on the vertebrate fauna that has a bearing on the palaeoecological interpretation and the biostratigraphical evaluation of the travertine deposits at Weimar-Ehringsdorf are presented. Aspects of the geology and archaeology that might contribute to a better understanding of the Weimar-Ehringsdorf site are also briefly discussed.

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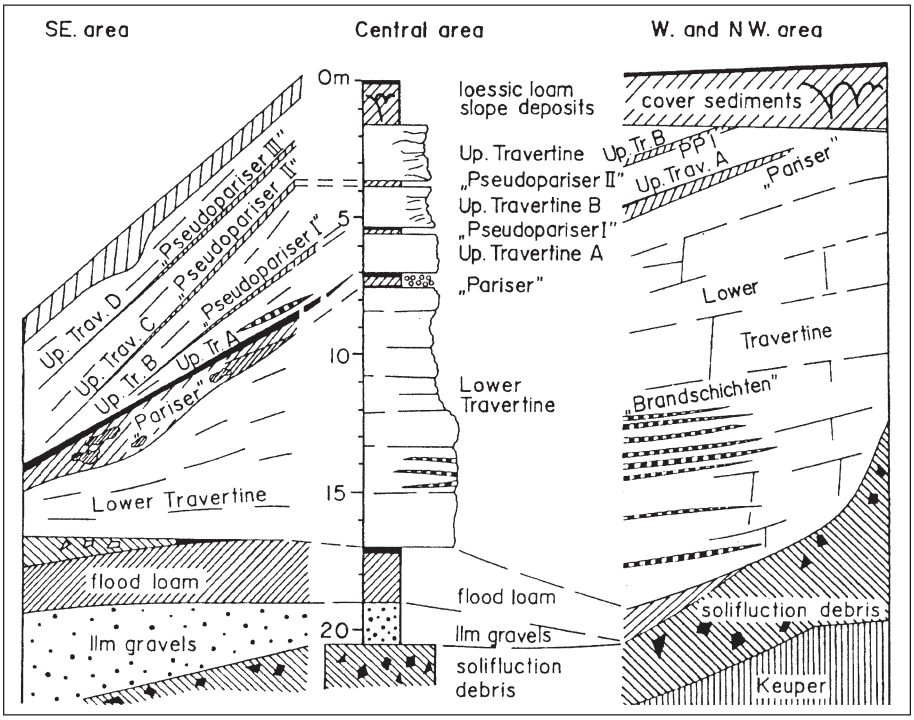

Fig. 1: Standard profile for Weimar-Ehringsdorf (based on Steiner 1979: 36, fig. 16; modified by Meyrick & Schreve 2002: 164, fig. 12.1)

Geology

The renowned geological profile of Weimar-Ehringsdorf (Lower Travertine, Pariser Horizon, and Upper Travertine I and II divided by the Pseudopariser) is based primarily on the works of Soergel (e.g., 1940). The 'Standard profile' produced by this famous scientist was for a long time the fundamental basis for several campaigns of field work carried out by other researchers. However, the outcrops and quarries of earlier times in Ehringsdorf were rather restricted and did not allow a truly three-dimensional reconstruction of the travertine sedimentation processes, especially in spite of the inclusion of intervening strata (e.g. the number and character of Pseudopariser). Only during the very extended exposures (opencast mining) in the late 1960s/early 1970s Steiner was able to find more detailed stratigraphic structures (fig. 1): „Contrary to Soergel's classification of the Upper Travertine (1926, 1940), at least in the southeast part of the Travertine field of Weimar-Ehringsdorf the Upper Travertine must be divided into four horizons (Upper Travertine A to D) with the Pseudoparisians (PP 1 to 3) situated between them. The bedding conditions are a decisive factor. The individual travertine horizons of the Upper Travertine do not lie horizontally one upon the other, but are imbricated side by side like tiles on the glacial valley wall of the river Ilm. As a result, in former times material was collected from the overlying horizons in individual exposures scattered over the entire travertine field. As has now become apparent, this material was erroneously assigned to the two horizons Upper Travertine I and II according to Soergel, and thus finds from quite different horizons were mixed. Thus contradictions that arose in the climatic and ecological interpretation of the material could now be eliminated" (Steiner 1973: 528). However, the call for a three dimensional reconstruction of the entire travertine field of Weimar-Ehringsdorf as a basis for validating of the most important palaeontological finds has had no consequences until now (Steiner 2003: 568). These are still restrictions in statements about some palaeontological elements (especially with ecologically conflicting implications) within the Upper Travertine. Here, we are also constraint in the continued absence of the integrating of palaeontological data with the three dimensional reconstruction of the travertine field, to use Soergel's (1926, 1940) popular profile.

Palaeontology

Samples from the travertine deposits of Weimar-Ehringsdorf have produced a diverse assemblage of microvertebrates, including amphibia, reptiles and mammals. Much of the material was collected by the washing and screening of soft sediments. To obtain skeletal remains from the travertine, the samples were dissolved in acetic acid (approx. 5 % by volume).

The lower part of the Lower Travertine yielded *Elaphe longissima* and *Castor fiber* (level 2) as well as interglacial mammals, including *Elephas antiquus, Stephanorhinus kirchbergensis, Dama dama, Sus scrofa,* and others (H.-D. Kahlke 1974, 1975a, R.-D. Kahlke 1995) indicating a period during which mixed deciduous forests dominated the landscape (figs 2, 3). By contrast, a rich microvertebrate

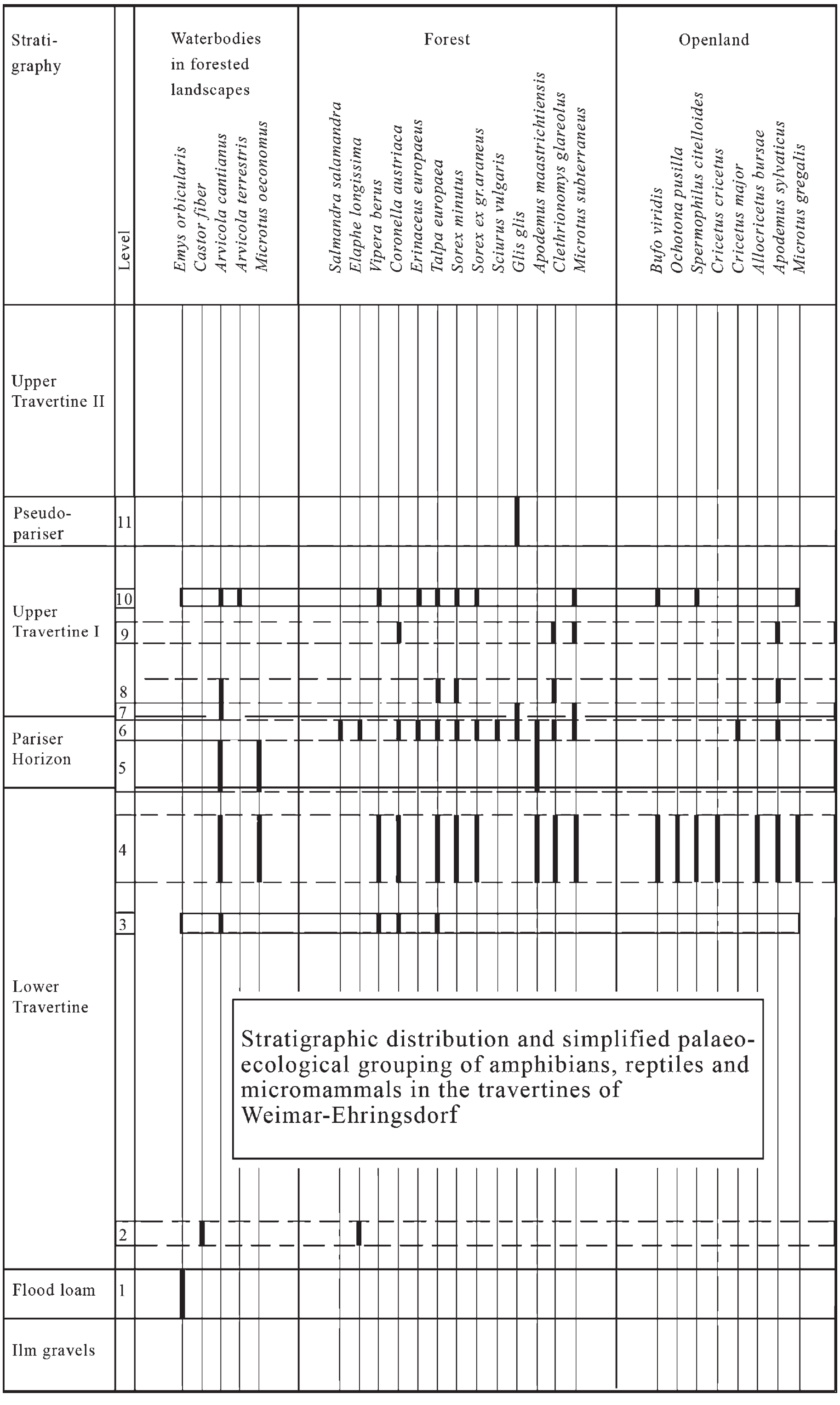

Fig. 2: Stratigraphic distribution and simplified palaeoecological grouping of selected amphibians, reptiles and micromammals in the travertines of Weimar-Ehringsdorf. Source: Heinrich (1981, 1994), Schäfer (1986), Böhme & Heinrich (1994), Böhme (2003). Note that the stratigraphic position of level 6 is still disputed. Note also that the exact stratigraphic position of *Emys orbicularis* within the Lower Travertine is unknown.

Find levels for the microvertebrates: 1 – Flood loam; 2 – Beaver Bed within the lower part of the Lower Travertine; 3 – Cavern infillings intercalated in the upper part of the Lower Travertine; 4 – Lower Travertine, approximately 1.0–3.5 m below the basis of the Pariser Horizon; 5 – Pariser Horizon, including humous silts and travertine sands at its base; 6 – Sediments between the top of the Pariser Horizon and the base of the Upper Travertine; 7 – Boundary interval between the uppermost part of the Pariser Horizon and lowermost part of the Upper Travertine; 8 – Travertine sand within the lowermost decimetres of the Upper Travertine; 9 – Upper Travertine, about 1.0 m above the top of the Pariser Horizon; 10 – Colluvial chernozem deposits of cavern fills of the Upper Travertine; 11 – Pseudopariser Horizon.

assemblage containing *Vipera berus*, *Bufo viridis*, *Ochotona pusilla* and *Microtus gregalis* collected from the upper part of the Lower Travertine (level 4) points to cooler and more continental open land conditions (fig. 2). This conclusion is in accordance with the absence of *Elephas antiquus* and *Stephanorhinus kirchbergensis* and the occurrence of *Stephanorhinus hemitoechus* (fig. 3). Moreover, rodent (e.g., *Arvicola cantianus*) and reptile fossils (e.g., *Vipera berus, Coronella austriaca*) were recovered from cavern infill sediments (level 3), but require further study.

Arvicola cantianus (Heinrich 1982, 1987), *Castor fiber* (Kretzoi 1977, Heinrich 1991), and *Stephanorhinus kirchbergensis* (van der Made 2000), from the Lower Travertine, are distinctly more primitive than those from the travertine deposits of Taubach. This strongly indicates that the Lower Travertine from Weimar-Ehringsdorf is older than the Eemian

Stratigraphy	Elephants	Rhinos	Horses	Cervids	Suids	Carnivores
Upper Travertine II		*Stephanorhinus hemitoechus* *Stephanorhinus hemitoechus*	(*Equus* sp., Upper Travertine, precise stratigraphic position within this unit unknown)	*Cervus elaphus*, *Megaloceros giganteus antecedens*, *Capreolus capreolus*		(*Ursus spelaeus*, *Ursus arctos* ?, *Canis lupus*, *Panthera spelaea*, *Mustela* sp., *Martes martes*, *Meles meles*; Upper Travertine, precise stratigraphic position within this unit unknown)
Pseudopariser		*Coelodonta antiquitatis* ?				
Upper Travertine I	*Mammuthus primigenius*, *Mammuthus trogontherii-primigenius*	*Coelodonta antiquitatis*, *Stephanorhinus hemitoechus*		*Cervus elaphus*, *Megaloceros giganteus antecedens*, *Capreolus capreolus*, *Alces latifrons postremus*, *Rangifer tarandus* ?	*Sus scrofa*	
Sediments between the top of the Pariser Horizon and the base of the Upper Travertine I				*Capreolus capreolus*	*Sus scrofa*	*Martes martes*, *Ursus* sp., *Crocuta crocuta spelaea*, *Vulpes vulpes*
Pariser Horizon	*Mammuthus primigenius* ?	*Stephanorhinus hemitoechus*		*Megaloceros giganteus antecedens*, *Rangifer tarandus* ?		*Ursus* sp.
Lower Travertine	*Elephas antiquus*	*Stephanorhinus hemitoechus*, *Stephanorhinus kirchbergensis*	*Equus chosaricus* *Equus chosaricus*	*Alces latifrons postremus*, *Megaloceros giganteus antecedens*, *Cervus elaphus*, *Capreolus capreolus*, *Dama dama*, *Megaloceros giganteus antecedens*, *Cervus elaphus*, *Capreolus capreolus*	*Sus scrofa*	*Ursus spelaeus*, *Ursus arctos*, *Ursus thibetanus*, *Canis lupus*, *Vulpes vulpes*, *Lynx lynx*, *Martes martes*, *Meles meles*, *Cyrnaonyx antiqua*, *Crocuta crocuta spelaea*
Flood loam		*Coelodonta antiquitatis*				
Ilm gravels	*Mammuthus primigenius*	*Coelodonta antiquitatis*				

Fig. 3: Stratigraphic distribution of selected large mammals in the travertines of Weimar-Ehringsdorf. Source: H.-D. Kahlke (1974, 1975a), Schäfer (1991), Böhme & Heinrich (1994) and van der Made (2003). Note that the stratigraphic position of the sediments between the top of the Pariser Horizon and the base of the Upper Travertine is still disputed.

travertine of Taubach. The occurrence of *Equus chosaricus* (Eisenmann 1991), *Megaloceros giganteus antecedens* (van der Made 2003), *Apodemus maastrichtiensis* (Heinrich 2003) and the evolutionary level of *Cyrnaonyx* cf. *antiqua* (Heinrich & Fejfar 1988) also suggests a pre-Eemian age for the Lower Travertine. Based on these biostratigraphic criteria, the fauna of the Lower Travertine at Weimar-Ehringsdorf most likely represents an intra Saalian warm period.

A microvertebrate assemblage with *Elaphe longissima*, *Salamandra salamandra*, *Lacerta agilis*, *Erinaceus europaeus*, *Sciurus vulgaris*, *Glis glis*, etc., collected from deposits between the top of the Pariser Horizon and the base of the Upper Travertine (level 6), is of forest type, testifying to temperate (interglacial) conditions. The occurrence of *Apodemus maastrichtiensis* could indicate an interglacial that is older than the Eemian. The precise stratigraphic position of this microvertebrate-bearing deposit (level 6) within the standard profile of the travertine at Weimar-Ehringsdorf is still under debate (e.g., fissure filling: Mania 1993, 1997, however doubted by Weber et al. 1996: 30, footnote 2; sediments deposited after local erosion of the Pariser Horizon: Böhme 2003).

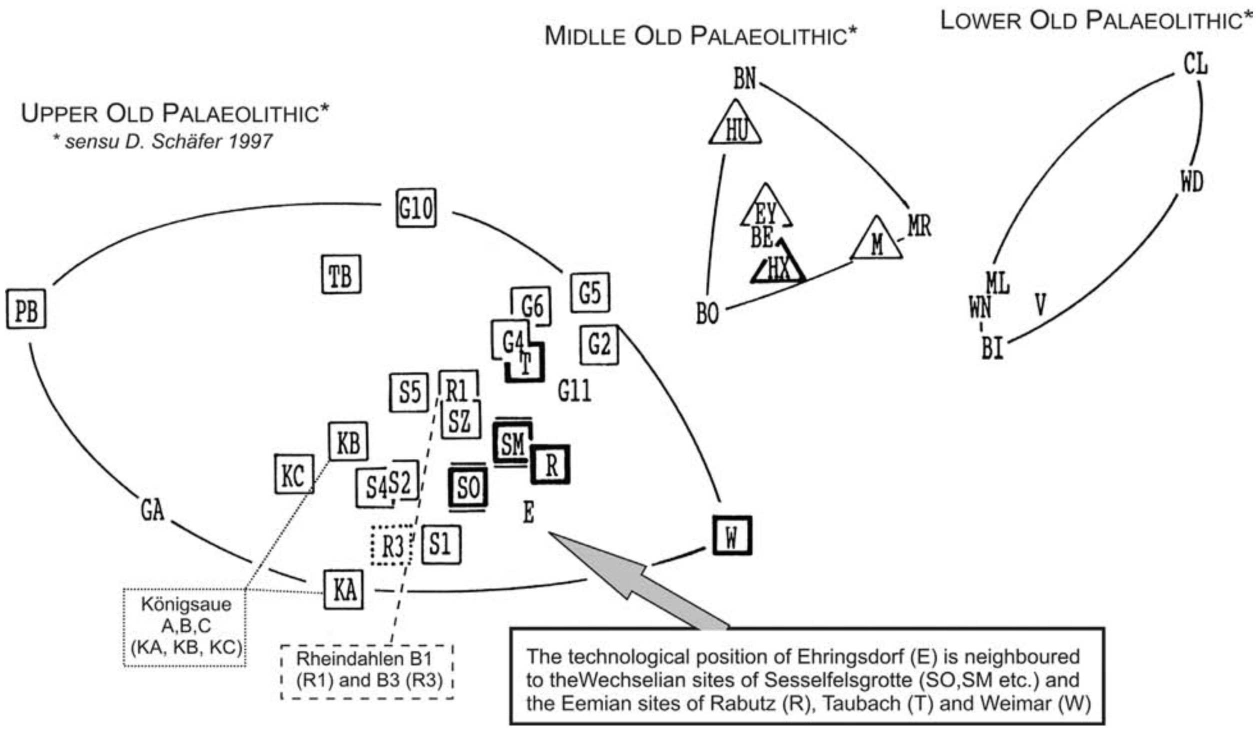

Fig. 4: Multidimensional scaling (MDS) of 16 attributes of flake production for 39 sample units (Schäfer 1997: 144, fig. 50; supplemented). For the attributes included in the analysis see Schäfer (1997: table 34; also p. 142-147 and note 249). Abbreviation for sample units:
Lower Old Palaeolithic: BI – Bilzingsleben / Thuringia; CL – Clacton on Sea / Great Britain; ML – Memleben / Saxony-Anhalt; V – Vértesszőlős / Hungary; WD – Wallendorf / Saxony-Anhalt; WN – Wangen / Saxony-Anhalt.
Middle Old Palaeolithic: BE – Bertingen / Saxony-Anhalt; BN – Barleben / Magdeburg-Nord / Saxony-Anhalt; BO – Bottrop / North Rhine-Westfalia; EY – Eythra / Saxony; HU – Hundisburg / Saxony-Anhalt; HX – Hoxne / Great Britain; M – Markkleeberg 1 / Saxony; MR – Magdeburg-Rothensee / Saxony-Anhalt.
Upper Old Palaeolithic: E – Weimar-Ehringsdorf / Thuringia; G10 – Große Grotte 10 Blaubeuren / Baden-Württemberg; G11 – Große Grotte 11 Blaubeuren / Baden-Württemberg; G2 – Große Grotte 02 Blaubeuren / Baden-Württemberg; G4 – Große Grotte 04 Blaubeuren / Baden-Württemberg; G5 – Große Grotte 05 Blaubeuren / Baden-Württemberg; G6 – Große Grotte 06 Blaubeuren / Baden-Württemberg; GA – Gamsenberg; Oppurg / Thuringia; KA – Königsaue A3 / Saxony-Anhalt; KB – Königsaue B2/4 / Saxony-Anhalt; KC – Königsaue C / Saxony-Anhalt; PB – Petersberg near Halle / Saxony-Anhalt; R – Rabutz / Saxony-Anhalt; R1 – Rheindahlen B1 (Westwand) / North Rhine-Westfalia; R3 – Rheindahlen B3 (Ostecke) / North Rhine-Westfalia; S1 – Sesselfelsgrotte G1 Essing / Bavaria; S2 – Sesselfelsgrotte G2 Essing / Bavaria; S4 – Sesselfelsgrotte G4 Essing / Bavaria; S5 – Sesselfelsgrotte G5 Essing / Bavaria; SM – Sesselfelsgrotte M1 Essing / Bavaria; SO - Sesselfelsgrotte O1 Essing / Bavaria; SZ – Salzgitter-Lebenstedt / Lower Saxony; T – Taubach / Thuringia; TB – Tönchesberg 2B / Rhineland-Palatinate; W – Weimar / Thuringia.

By contrast, microvertebrate assemblages from the lower part of the Upper Travertine I (sensu SOERGEL 1926) (level 9) are insufficiently known to permit precise reconstruction of environmental conditions (fig. 2). The rodent assemblage includes *Apodemus sylvaticus*, *Cletherionomys glareolus* and *Microtus subterraneus*, which could indicate temperate conditions, whereas *Mammuthus primigenius* and *Coelodonta antiquitatis* from the same level (fig. 3) suggest that there may have been a deterioration of the climate. Unfortunately, the precise stratigraphic range of most large mammals within the Upper Travertine as well as the Lower Travertine is far from clear, since the exact assignment of the palaeontological finds to distinct stratigraphic units of the Upper Travertine is still uncertain.

A land vertebrate assemblage (e.g., *Bufo viridis*, *Lacerta vivipara*, *Spermophilus citelloides*, *Microtus gregalis*) from colluvial chernozem deposits (level 10) of cavern fills of the Upper Travertine is predominantly of steppe or forest steppe type, testifying to continental conditions (fig. 2). The composition of the assemblage and the evidence of an early *Arvicola terrestris* suggest that this vertebrate fauna dates from the Early Weichselian (BÖHME 2003, BÖHME & HEINRICH 1994).

Archaeology

On the basis of an archaeological attribute system 900 stone artefacts (cores, flakes, tools) from Weimar-Ehringsdorf (Lower Travertine) were analysed in 1979/1980. This method considers technological attributes of blank production as well as attributes of the retouch process. Since that work more than 20000 artefacts from more than 50 inventories of Middle and Late Pleistocene age in Europe were added to the database. The task was to discover possible clusters of sites with similar attributes. Despite this type of approach the unretouched flakes showed the best discrimination and this was independent of the typological character of the tool inventory. As a result three pre-Upper Palaeolithic technological units could be recognized on the basis of several methods (univariate and multivariate statistics; SCHÄFER 1993). They clearly show a chronological gradient. It should be stressed that the chronological judgement for any inventory is based on facts independent of classical archaeological reasoning, but rest upon geochronological, palaeontological and radiometric arguments. Only if the technological similarity/dissimilarity of well dated archaeological inventories is known one can also include those sites under discussion, in spite of their chronological status. On this basis we can recognize the very strong similarity of artefacts from Weimar-Ehringsdorf to those of Eemian and early Weichselian age (e.g. Taubach, Rabutz, Königsaue etc.) (fig. 4). As a consequence of the attribute analysis point of view we have also argued for an Eemian age for the Lower Travertine of Ehringsdorf (SCHÄFER 1991). But, if the chronological basis for integrated sites is changing one has to re-consider the results achieved from the former arguments. This is now the case for the artefacts from Mönchengladbach-Rheindahlen (Lower Rhine loess area), which are also very similar to the Ehringsdorf artefacts. The included strata (B3 and B1) were traditionally viewed within an early Late Pleistocene context. Re-examination by the team of W. SCHIRMER (SCHIRMER 2002) has yielded several arguments for a Middle Pleistocene age for this strata and therefore also for the included artefacts. Further confirmation of this result would be an additional argument to scrutinize chronological arguments within and between the attribute analysis based clusters of our sites. In this case it seems that time is not the only dimension within our site (SCHÄFER in press).

Conclusions

The Pleistocene travertine site at Weimar-Ehringsdorf has long been known as a source of abundant floral, faunal, and human remains. Despite the long history of research, which can be traced as far back as the 18th century, essential questions referring to the site still remained unsolved. Microvertebrates including amphibia, reptiles and small mammals recovered from the well known travertines at Weimar-Ehringsdorf during the last decades are briefly reviewed. Eleven levels with microvertebrate remains have been recognised so far. The microvertebrate assemblages reflect repeated climatic changes that range from full interglacial (e.g. Lower Travertine, level 2; sediments between the top of the Pariser Horizon and the base of the Upper Travertine, level 6) to distinctly cooler and drier continental conditions (e.g., Lower Travertine, level 4). There is insufficient detail at present to reconstruct the climatic conditions and the age of the Pariser Horizon and the Upper Travertine. A microvertebrate assemblage obtained from colluvial chernozem deposits of cavern fills of the Upper Travertine (level 10) indicate steppe or forest steppe landscapes and appears to be of Weichselian age. The evolutionary level of several rodents (*Castor*, *Arvicola*) and macromammals (e.g., *Equus*, *Stephanorhinus*, *Megaloceros*, *Cyrnaonyx*) suggests that the Lower Travertine at Weimar-Ehringsdorf is older than the Eemian travertine at Taubach. Based largely on this, the Lower Travertine at Weimar-Ehringsdorf is considered to be a warm period of the Saalian. An attribute analysis of artefacts from the Lower Travertine shows closest similarities to early Weichselian and Eemian inventories. Indeed, a possible pre-dating of the Rheindahlen complexes R1 and B3 gives indications of a more complex content within the configuration achieved by technical archaeological studies. The precise allocation and interpretation of many palaeontological remains requires further study, since the call for a three dimensional reconstruction of the entire travertine field of Weimar-Ehringsdorf as a basis for the validation of the palaeontological finds has had no impact until now.

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