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UPPER PLEISTOCENE CHRONOSTRATIGRAPHY OF NORTH-EASTERN HUNGARY

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Principles of the elaboration of an Upper Pleistocene chronostratigraphy

Over the last years Hungarian Paleolithic researches had to face an ever increasing demand to elaborate an up-to-date chronostratigraphic system suitable for correlating similar data within Europe.

For the Middle and Upper Paleolithic (in the conventional sense 130,000-10,000 B.P.) this chronostratigraphic system has been already elaborated by the author in his study "Geomorphological horizons and their archeological data in NE Hungary; the Upper Pleistocene chronostratigraphic system of river terraces, loesses and cave sediments" (RINGER 1993). This work was especially reasonable because in the NE region of the country – in the birthplace of Paleolithic and Mesolithic researches of Hungary – after those excavations which were made till the sixties almost exclusively in cave sites, a great number of open-air sites had been unearthed. The chronological determination and the correlation to Paleolithic caves of these sites became possible only by the joint and complex study of litho-, bio-, archeostratigraphic and radiometric data.

For some decades loess- and paleopedo-stratigraphy and -chronology are the most accepted disciplines that can be used even over large areas in international stratigraphic-chronological correlation studies. Therefore, these remained the basis of our elaboration, too. Consequently, from open-air Paleolithic sites, those sequences were chosen which contains as much paleo-soils as possible suitable for interregional correlation and also the ones which yielded rich bio- and subaeric and archeostratigraphic data. Besides, we tried to correlate subaeric and cave sequences. Among our sites (Fig. 1) the double sequence of the Diósgyőr-Tapolca cave in downtown, of Miskolc with its gradual transition between the cave and subaeric deposits, proved to be excellent for this purpose.

These layers had been deposited on the same river terrace or adjoining to it, syngenetically. Therefore their correlation is unambiguous. The basic principles of layer correlation for Upper Pleistocene sequences in NE Hungary are as follows:

1. The subaeric loess, loessy sand, sandy loess of the cooling periods corresponds with cave loess that occurs at the entrances and in the foreparts of the interior of the caves.
2. In the warmer periods, soils at open-air sites continuously turn into "cave soil" – at least in the fore-parts of the interior of caves – while the soils in the interior of the caves are colluvium which is originated from the surface through the fissures and breaks of the rocks.

This principles of correlation between cave and open-air sedimentation were recognized by Jenő Hillebrand, pioneer scholar of Hungarian Paleolithic researches who expressed them with the following words (HILLEBRAND 1935: 38-39): *"Die Ausfüllungen der Höhlen sind zwar sehr mannigfaltig, trotzdem lassen sich diese in grossen Zügen durch ein gemeinsames*

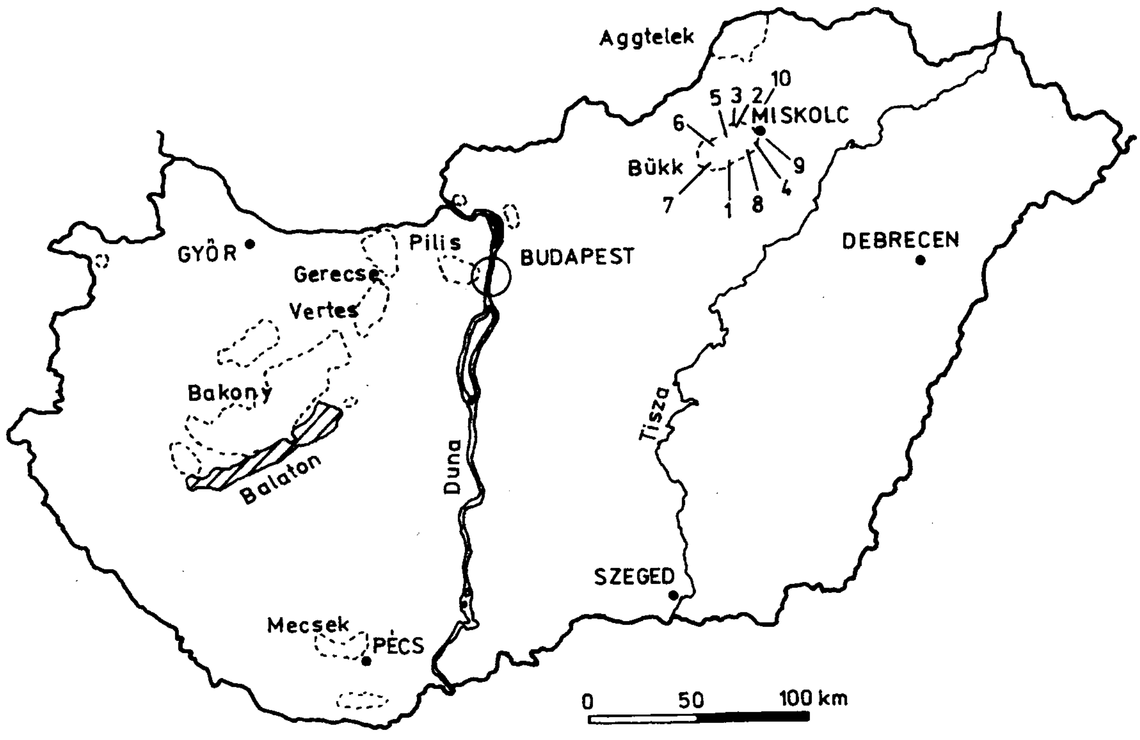

Fig. 1. Cave sites and open-air sites studied in North-Eastern Hungary: 1. Suba-lyuk cave; 2. Sajóbábony-Méhész-tető – open-air site; 3. Sajószentpéter-Magit-kapu-dűlő – open-air site; 4. Mályi-Öreghegy – open-air site; 5. Szeleta cave; 6.Lambrecht Kálmán cave; 7. Balla cave; 8. Diósgyőr-Tapolca cave; 9. Ónod – open-air site; Szirmabesenyő – open-air site

ideales Schema veranschaulichen. So sind die untersten Schichten, die auf dem anstehenden Felsenboden lagern, zumeist durch einen rötlichen oder gelben plastischen Lehm vertreten, der sich einmal in fliessendem Wasser, ein anderesmal aber in stagnierendem Wasser gebildet hat, und in petrographischer Hinsicht immer vom eigentlichen Höhlenlehm abweicht. Er führt öfters Kieseln oder Sand und ist fast immer steril. Nur ausnahmsweise finden sich darin zumeist eingeschwemmte Tierknochen oder Holzkohlen. Noch seltener sind Gerätfunde. Die jüngeren Schichten sind im Allgemeinen durch hellere, gelblich rote und dünklere braune Lehmschichten vertreten, die mit einander abwechseln. Die obersten diluvialen Schichten sind zumeist gelblich grau und lössartig. Die dunkelbraune Färbung der Schichten könnte öfters durch die verschiedenen organischen Abfällen bedingt sein, oder manchmal auch von den zerriebenen Holzkohlen verursacht worden sein. Nach meinen neuesten Erwägungen dürfte aber diesen verschiedenen Färbungen eine viel wichtigere Bedeutung zufallen. Wenn wir nämlich den Umstand vor Augen halten, dass in fast jeder Höhle die oberste holocéne Schichte durch Humus gebildet ist, so erscheint es als absolut logisch anzunehmen, dass auch im Diluvium während der värmeren Zeitabschnitte, als sich in unseren Gegenden auch Laubwälder ausbreiteten, also Humus auftrat, ein solcher sich auch in den Höhlen gebildet haben musste. Und weiter gehend dürfte man in diesem Falle annehmen, dass die dünklere, zumeist braune Färbung unserer Höhlenlehmschichten mit einem Humusgehalt in Zusammenhang zu bringen sei. Ich werde diesbezüglich chemisch-geologische Untersuchungen anstellen lassen, um diese Frage endgültig lösen zu können.

Jedenfalls liessen sich diesbezüglich einstweilen folgenda sehr interessante Beobachtungen machen. Die Höhlenlehmschichten, die dem Aurignacien oder Protosolutréen, angehören, also in solche Zeitabschnitte fallen, die durch ein mässig warmes Klima ausgezeichnet sind, (und daher die Bedingungen für Humusbildung gegeben waren), sind sehr häufig dunkelbraun gefärbt, hingegen sind die Schichten des Spätmoustérien, Hochsolutréen und Altmagdalénien, die sich während einem kalten Klima (subarktische Steppe) abgelagert haben, durchwegs gelb, oder rötlich. Einstweilen unterstützen also diese Feststellungen unsere oben erörterte Annahme, nach der die verschiedene Färbung der Höhlenlehme von den verschiedenen Klimaten abhängen würde. Die braunen Höhlenlehmschichten könnte man also, unserer Meinung nach, in genetischer Hinsicht z.B. mit der "Göttweiger Verlehmungszone" J. Bayer's parrallelisieren, die nach ihm ebenfals humosen Einschlag aufweist."

During our work on paleopedostratigraphic correlation we took advantage of the geographic situation of our sites. All sites which we had chosen for the study are situated around the town of Miskolc within only a few km's distance from it and there are only minor differences in their elevation. Therefore we may suppose that in the warmer and cooler periods of he Pleistocene similar homogeneity of climatic ecological and topographical factors existed as the one we experience today in this region. So we may reasonably suppose that within this rather small region the formation of soils and layers deposited during well-defined climatic phases were also similar.

Within our chronostratigraphic system different soil types and their corresponding ones in the caves are marked by letters formed from the name of the site and when it seemed necessary they are denoted by numbers, too (Fig. 2).

To make a regional correlation comparison the most promising paleosoil layers were the ones that appear at the bases and in the upper third parts of the subaeric sequence (corresponding to the sense alto Eem and Hengelo-Denekamp warmer periods).

The paleo-pedocomplex of the Western European Rocourt-Warneton last interglacial period (Eem-Amersfoort-Brörup-Odderade) corresponds to the base part of the subaeric sequence which is a polygenetic forest soil overlaid by a complex paleosoil sequence (marked as Ma1 and containing several members of grey forest soil and/or chernozem – like soils).

At the conference organized to commemorate the 100th anniversary of the beginning of Paleolithic researches in Miskolc, Hungary, this soil complex of three sites – at Sajóbábony-Méhész-tető, Mályi-Öreg-hegy and Sajószentpéter-Margit-kapu-dűlő – was accepted as the NE Hungarian stratotype of the last interglacial sensu lato by the common opinion of Paul Haesaerts, Marcel Otte, Janusz K. Kozlowski, Avraham Ronen and others.

Bábonyian, related to the oldest phase of the Central European Micoquian and to the Taubachian archeological cultures described by Karel Valoch (VALOCH 1971) is a characteristic archeostratigraphic element which can be connected to the above-mentioned double pedo-complex. It is suitable for international correlation, too. The biostratigraphic studies of these sites also supports these results. The vegetation and fauna of the Eem period was characterised with the species of hornbeam – oak (*Carpinus – Quercus*) vegetation; *Hystrix vinogradovi* and a mollusc, *Helicigona banatica*, which species were found in the pedocomplex of the base part of these sites too.

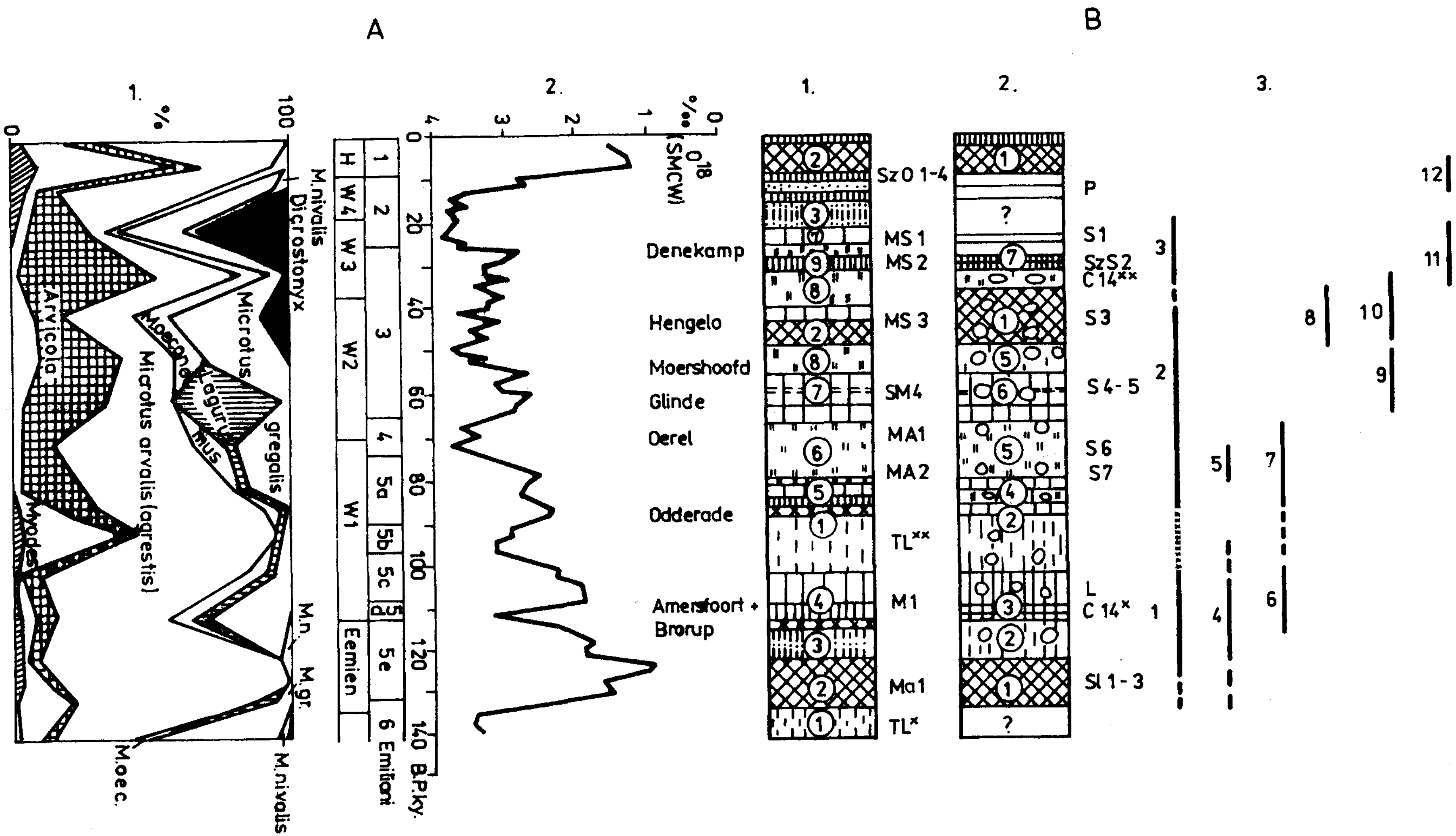

Fig. 2. The chronostratigraphic system of the Upper Pleistocene subaeric and cave sediments of NE Hungary correlated to the Arvicolidae stratigraphy (KORDOS & RINGER 1991)

Legend of Fig. 2:

A. The Arvicolidae stratigraphy of the Hungarian Upper Pleistocene

1.) Micromammal successions

2.) Climate diagram of vole thermometer (dotted line) in relation to the climate diagram of the Upper Pleistocene (LABEYRIE 1984)

B. Subaeric and cave sediments, archeological cultures

1.) *Subaeric sediments*

1. loess; 2. brown forest soil; 3. sandy loess – loessy sand; 4. a soil complex with a partly chernozem-like character, complex also regarding its genetics; 5. lower, grey forest soil member of a double soil complex; 6. upper, steppe soil member of a double soil complex; 7. forest steppe soil with pseudomycelia; 8. gelisolifluction loess-like sediment; 9. chernozem or forest or forest steppe soil turned into chernozem

Explanation of letters: Ma1 = Mályi clay pit soil 1.; M1 = Miskolc paleopedocomplex; MA1+MA2 = (Miskolc-) Avas1-Avas2 paleopedosoil; SM4 = Sajószentpéter 4th paleosoil; MS3 = Miskolc-Sajószentpéter 3th paleosoil; MS2 = Miskolc-Sajószentpéter paleosoil 2; MS1 = Miskolc-Sajószentpéter, paleosoil 1.; SzO 1, 2, 3, 4 = 1-4 paleosoil of Szirmabesenyő-Ónod

2.) *Cave sediments*

1. Cave soil syngenetic with the formation of brown forest soil or of brown rendzina; 2. loess-like sediment with angular limestone detritus (= "cave loess"); 3. cave soil complex with a peculiar complex genetics; 4. double cave soil; 5. "cave loess" with rounded limestone detritus; 6. poorly developed, duplicated cave soil; 7. rendzina-like (dark grey) cave soil.

Explanation of letters:

Sl 1-3 = cave soil of layers 1-3 of Suba-lyuk; L = cave soil complex of layers 4-5 of Lambrecht Kálmán cave; S6+S7 = the double cave soil complex of the 10th and 12th layers of Suba-lyuk; S4-5 = the duplicated (grey) cave soil of the "shaft" of Suba-lyuk (8th and 10th layers); S3 = the cave soil of the 6th layer of the "shaft" of Suba-lyuk; SzS2 = the (dark grey) cave soil of the 4th layer Szeleta cave; S1 = the brown cave soil of the 3rd layer of the "shaft" of Suba-lyuk and of the 5th layer Szeleta cave, according to the numbering of Kadić's 1916 stratigraphic sequence in the Szeleta cave.

3.) *Archeological cultures*

Explanation of numbers:

1 = Bábonyian; 2 = Early Szeletian; 3 = Advanced Szeletian; 4 = Bükk Mts. Taubachian; 5 = Middle Paleolithic with denticulated tools (Miskolc-Avas-Tűzköves); 6 = Typical Mousterian rich in scrapers; 7 = Charentian rich in Suba-lyuk type denticulated tools (Suba-lyuk layers 10-14); 8 = transitional Late Mousterian industry of the 5th layer of Sajószentpéter-Margit-kapu-dűlő; 9 = Bükk Mts. Aurignacian I; 10 = Bükk Mts. Aurignacian II.; 11 = Gravettian; 12 = Late or Cave Gravettian

On the basis of these relative chronological arguments the pedological stratotype can be assigned to the last interglacial.

Recently Manfred Frechen (University of Cologne) has determined the age of the Ma1-M1 using TL data. At Sajóbábony-Méhész-tető the TL age of the loess of the underlying layer of the sensu lato Eem soil is 157.9 ± 23.5 and 173.0 ± 14.2 ka. At the Margit-kapu-dűlő at Sajószentpéter the TL age of the loess overlying the M1 soil complex is 85.3 ± 7.0 and 101.4 ± 9.0 ka.

In the upper third of subaeric sequences, a double paleo-pedocomplex is deposited. The lower member of this complex is a pseudogleyic brown forest soil with (MS3), while its upper member is a paleosoil of grey forest soil type (MS2). The lower member of the complex yielded an archeological material of Middle Palaeolithic/Upper Paleolithic transitional character while in the upper one Aurignaco-Gravettian type material was found.

This peculiar paleo-pedocomplex can be correlated with the soil complexes of Stillfried B in Austria and PK III in Moravia. Among its parallels in cave layers (S3-SzS2) there is a cave soil (SzS2) which corresponds to the upper member of the buried soil complex. A ^{14}C age of a sample taken from a few cm's depth below this cave soil in the Szeleta cave is 32,480 ± 520 (RINGER 1993). This age suggests that the subaeric and cave soil formations belong most probably to the Denekamp interstadial (Fig. 2). The archeostratigraphic data known from formation of these layers corroborate this.

The paleo-humanecological characteristics of oxygen isotope stages 5-2 in Northeastern Hungary (Fig. 2)

Emiliani's stage 5

Sub-stage 5e

Paleo-pedostratigraphy-lithostratigraphy: the brown forest soil with pseudogleyization of the loess sequences (Ma1) corresponds with the brown rendzina type cave soil (Sl1-3) which both connected to the climatic optimum of Eem.

Biostratigraphy: Both in the flora and the fauna the species of the temperate zone are dominant, without exotic elements. The spread of hornbeam – oak (*Carpinus - Quercus*) vegetation is characteristic of the sub-stage.

Archeostratigraphy: The Typical Mousterian of Levalloisian debitage, rich in scrapers can be found in the Suba-lyuk cave of the Bükk Mts., had immigrated to this region in this period probably from the Mediterranean due to a climatic change, an extension of the Mediterranean climate to the North. Here, in the same period the Bábonyian culture flourished with polygenetic origin. Typical Mousterian inhabited mainly in the South part of the Bükk Mts. while the settlements of Bábonyien were concentrated in the Eastern Bükk region.

Sub-stage 5d

Lithostratigraphy: sandy loess layer in loess sequences; in caves a sandy, loessy filling with limestone debris are characteristic of this sub-stage.

Biostratigraphy: In the flora pine and larch species (*Larix-Picea*) and fauna, northern, cold indicator species (*Microtus gregalis*) appeared.

Archeostratigraphy: Besides Typical Mousterian and Bábonyian the Taubachian described by Karel Valoch (VALOCH 1971) had immigrated into the region from the North, probably due to the fall in temperature.

Sub-stages 5c-5a

Paleo-pedo- and lithostatigraphy: In subaeric secquences a paleo-pedo-complex (M1) consisting of composed grey forest soil and chernozem-like soils and its parallel cave soil marked corresponds to the 5c and 5a warm periods. The loess deposits of the 5b substage is interlayered.

Biostratigraphy: Both in the flora and fauna species with temperate climate character are dominant; in the arborescent vegetation *Celtis australis* is still present likewise *Hystrix vinogradovi* in the fauna (5c, 5a substages).

Archeostratigraphy: the previous archeological cultures flourish continuously.

Stage 4

Lithostratigraphy: In this stage the thickest loess sequence of our region had been accumulated. In contradiction to the usual character of loess this type of loess is less clayey.

Within the loess formation there is a characteristic double grey forest soil (MA1-MA2). Their parallels in the caves deposit over each other also characteristic with a little difference between each other (S7-S6).

Biostratigraphy: In the dominating pinewoods vegetation the presence of *Pinus cembra* indicates an intensive fall of temperature: as for the fauna this climate phase is marked by the mass appearance of *Lagurus lagurus* for the first time in Hungary (KORDOS & RINGER 1991). The vegetation of those soil formations which are connected to rise in temperature consists of temperate forest species, with *Tilia* among then.

Archeostratigraphy: It is very probable that the disappearance of the Typical Mousterian and of Taubachian from the Bükk Mts. was due to the sharp deterioration of climate. They were succeeded by the Subalyuk type charantian (RINGER 1990), while in this period evolves Early Szeletien from the Bábonyian.

Stage 3

Paleo-pedostratigraphy, lithostratigraphy: In subaeric sequences it can be characterised by at least three intensive soil formation phases. In chronological order: they are as follows a steppe soil can be connected with the Moershoofd interstadial (SM4), a brown forest soil with pseudogleyization can be correlated to the Hengelo interstadial (MS3) and a grey forest soil can be connected with the Stillfried B period rise in temperature (MS2). Their parallels in caves are the cave soils S4-5, S3 and SzS2 ones, respectively.

Biostratigraphy: The flora remains of soils can be correlated with the Hengelo-Stillfried warming periods and their corresponding deposits in caves can be characterized by the presence of *Carpinus* and *Quercus* as well as *Fagus* associations, while as reads their faunas the joint occurrence of *Capreolus capreolus*, *Sus scrofa*, *Arvicola* and of other species indicating temperate climate is characteristic of them. The severe deterioration of climate following the Hengelo is represented by the mass distribution of *Dicrostonyx torquatus*.

Archeostratigraphy: In the Western side of the Bükk Mts. the Bükk Aurignacian I.-II., while in the eastern region of the mountains with today's Miskolc in its center, the Szeleta culture flourished beside each other.

Stage 2

Paleo-pedostratigraphy-lithostratigraphy: This climatic phase is known in our region rather poorly both in the loess sequences and in cave sediments. The correlation of soil formation, loess and sandy loess layers is less cleared.

Biostratigraphy: For the mountains we may reconstruct a taiga-like forest with *Pinus cembra*. In the fauna cold indicator species are especially dominant, among them *Dicrostonyx torquatus* is the most characteristic.

Archeostratigraphy: For some time Aurignacian II. and the Evolved Szeletian still flourish synchronously at the two opposite sides of the Bükk Mts. In the pediment of the mountains the settlements of the Gravettian culture appeared. From the caves of the inner part of the region the traces of the settlements of the so-called Cave-Gravettian culture are known only rarely.

Finally I should like to express my thanks first of all to László Kordos, Endre Krolopp and Manfred Frechen for their help to make possible the above described elaboration of an Upper Pleistocene chronostratigraphy for NE Hurgary.

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