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Palaeoenvironmental changes during the Middle and Early Upper Paleolithic in the Upper-Tysa Depression, Ukraine (the Sokyrnytsya and Ruban' sites)

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Abstract. The aim of the study is the reconstruction of palaeoenvironments of the Middle and Early Upper Palaeolithic in the Upper-Tysa Depression, related to short-period Upper Pleistocene changes. Stratigraphical, palaeopedological, pollen and archaeological methodologies have been applied in the study of several excavations at the Sokyrnytsya

1 and Ruban' sites. Intense translocation processes (during formation of Luvisols and Albic Luvisols) during Late Pleistocene warm phases and Holocene, frequently transformed the material of underlying cold-phase non-soil sediments. The last are revealed in the lower horizons of palaeosols by their pollen assemblages, indicative of a periglacial climate, and by the levels with cryoturbations. The pollen succession of the last interglacial is found in the well-developed Kaydaky Luvisol. The presence of beech growing during the second half of the interglacial is a special feature of Transcarpathia. Above, two interstadials and two stadials are revealed in the early glacial. At Sokyrnytsya 1, Middle Palaeolithic first appeared at the very end of the last interglacial (when boreal forests dominated), and it is traced through sediments of the early glacial interstadials. The small collections of artefacts and the absence of specialized features on them do not allow them to be assigned to a specified technological-typological complex. During the interstadials of the early glacial ('p11' and 'p13'), Luvisols and Cambisols developed beneath woodland, dominated by pine, but with admixture of deciduous trees, under a south-boreal climate. The cultural level at Ruban', located in the transitional horizon from the late Pryluky soil to the Uday loess unit, is related to the Quina-type industry. Its analogues are quite common in Western Europe, but up to now have not been known to the east of the Carpathians. At that time, broad-leaved trees disappeared; the climate became cooler and drier. The presence of dry seasons is indicated by a level with abundant Fe-Mn concretions. At Sokyrnytsya 1, the Early Upper Palaeolithic non-Aurignacian cultural level is found in the Vytachiv unit (Middle Pleniglacial, around 38 - 39 ka BP). It is characterized by a technological-typological complex which has its analogue only in Eastern Europe (Kostenki XIV). In Vytachiv times, woodland, dominated by small-leaved trees, alternated with open landscapes of forbs and sedges. The climate was transitional from south-boreal to boreal. The Upper Palaeolithic level, which also is not related to a distinctive culture, is located above the level of the Bug (Late Pleniglacial), cryoturbations which deeply dissect the Vytachiv unit. The presence of both West European and East European archaeological industries and the exceptional palaeoenvironmental features of the studied area demonstrate its importance in the European context.

Key words: lithopedostratigraphy, palynology, short-period environmental phases, cultural levels.

Природні зміни впродовж середнього і раннього верхнього палеоліту у Верхньо-Тисненській улоговині, Україна (стоянки Сокирниця 1 і Рубань)

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Анотація. Реконструкція короткоперіодичних змін палеоекологічних умов середнього і раннього верхнього палеоліту у межах Верхньо-Тиської западини виконана на основі стратиграфічного, палеopedологічного, палінологічного та археологічного вивчення пізньоплейстоценових відкладів багатощарової стоянки Сокирниця 1 і середньопалеолітичної стоянки Рубань, а також порівняльного аналізу результатів їхнього дослідження із матеріалами з одноікових стоянок прилеглих територій. Встановлено специфічні риси будови розрізів району, зумовлені постседиментаційним перетворенням відкладів холодних етапів нисхідними процесами ґрунтоутворення під час формування бурих лісових лесивованих і підзолисто-буроземних

грунтів наступних теплих етапів. Виявлена циклічність екологічних змін впродовж останнього зледеніння – чергування трьох інтерстадіалів із лісо- та лісостеповими ландшафтами південно-бореального і бореального клімату із стадіалами, коли поширювалися відкриті ландшафти перигляціального типу. Простежено специфічні риси розвитку рослинності, притаманні останньому міжзледнінню у Закарпатті. На стоянці Сокирниця I середньопалеолітичні культурні шари виявлено починаючи від верхів кайдацького міжльодовикового кліматоліту до верхньоприлуцького до удайського кліматолітів встановлено середньопалеолітичну індустрію типу Кіна, поширену у Західній Європі, але наразі не виявлену на схід від Карпат. У витачівському кліматоліті (38–39 т. р. т.) виявлено культурний шар із техніко-типологічним комплексом раннього верхнього палеоліту, який не належить до оріньяку. Подібні комплекси простежені лише у Східній Європі (Костенки XIV).

Ключові слова: літо-педостратиграфічний аналіз, палінологія, короткоперіодична палеогеографічна етапність, культурні шари.

Introduction. The important task of the Quaternary stratigraphy and palaeogeography is to reveal the geological age of the Paleolithic cultures and to reconstruct the Ancient Humans' environments. A comparison of environments of the coeval cultures in different parts of Ukraine and the adjacent areas allows us to find out the impact of environmental changes on the distribution of the Paleolithic cultures and their changes in time. The area of Transcarpathia is of a particular interest in this respect as the connecting chain between Eastern and Central Europe. The aim of this study is to reveal changes in soil-sedimentation processes and vegetation through the time of Middle and Early Upper Paleolithic existence in the Upper-Tysa Depression. The ecotones of this area, transitional between the lowland and adjacent mountains of the Volcanic Carpathians, are particularly sensitive to climatic changes, reflected in palaeovegetation and palaeopedogenic processes.

By the end of the 1960es, two Paleolithic sites were known in the Transcarpathia: Mala Gora and Pavlova Gora (Skutil, 1938). V. Petrun' (1972) has gathered the Early and Middle Palaeolithic artefacts on the surface at Rokosove. The systematic search for Palaeolithic sites, which had been started in the Transcarpathia by the team of V. Gladilin in 1969, has led to the discovery of several dozens of loca-

tions with Palaeolithic artefacts, and the Molochnyi Kamin' Cave and Beregove 1 sites were excavated. Nevertheless, the archaeological map of the Transcarpathia looked much poorer in comparison with the adjacent areas where hundreds of Palaeolithic locations, including stratified sites, were known. The discovery of the multi-layered stratified Palaeolithic site at Korolevo (1974) was a fundamentally new step in the archaeological study of the region, which is a junction between the Palaeolithic realms of Central and Eastern Europe (Kulakovska, 1989; Gladilin, 1985; Gladilin, Sitlivy, 1990). The site first pointed at the geological age of the appearance of the early humans in the area of Ukraine. Ten Palaeolithic levels were recorded *in situ*. The collections of stone artefacts from different levels reflected the great variability of technical and typological traditions. At present, eight stratified Palaeolithic sites are known in the Transcarpathia: Korolevo 1, Korolevo 2, Beregove 1, Sokyrnytsya 1, Shayan 1, Malyi Rakovets' IV, Ruban' open-air sites and the cave site Molochnyi Kamin'.

The first studies in detail of stratigraphy, lithopedology and palynology of the Palaeolithic sites Korolevo 1 and Beregove 1 (Fig. 1) have been fulfilled by the team of O. Adamenko (Adamenko, Grodetskaya, 1987; Adamenko *et al.*, 1989). The multi-layered site Korolevo 1 is located on the high Lower Pleistocene terrace of the Tysa. Seven loess units and six palaeosol units of the Ukrainian stratigraphic framework (Veklich *et al.*, 1993) had been identified there, with M/B boundary located within the lowermost Martonosha soil. The paleoclimatic implication of the pollen data corresponded well with the glacial (loess) – interglacial (palaeosol) cycles. The new high-resolution pedostratigraphical study of Korolevo 1, with the application of OSL-dating and correlation with MIS, has been carried out by P. Haesaerts and L. Koulakovska (2006). The Beregove 1 site is situated in the IIIrd (the Late Pleistocene) terrace of Tisa, and it includes three loess and three soil units



Fig. 1. The sites' location

above the alluvial gravels. Pollen data from Vytachiv unit (the terrestrial equivalent of MIS 3) at Berego 1 (Yurchenko, 2017) has shown the temporal variability of the vegetation during this time, which indicates the existence of two interstadials, with distinct climatic optima, separated by a stadial. The pedomorphology of the Upper and Middle Pleistocene and palaeogeographical reconstructions, based on palaeopedology, have been carried out by Zh. Matviishina and S. Karmazinenko in the multilayered Malyi Rakovets IV site (Stepanchuk *et al.*, 2013; M. Yamada and S. Ryzhov, Eds., 2015), which is located on the slope of the Vyorlat-Hutinsky Ridge of the Carpathian Mountains, adjacent to the Upper-Tysa Depression. The Gat' site is located in the oldest terrace of Tysa, and it includes 20 units (Gerasimenko, Vozgrin, 2011) of Ukrainian stratigraphical framework of the Pleistocene. In this section, the Lower and Middle Pleistocene units are represented much more completely than the Upper Pleistocene, which deposits consist mainly from welded palaeosols. The complete pollen succession from the pedocomplex of Pryluky – Kaydaky units, which are regarded as the terrestrial equivalents of MIS 5 (Rousseau *et al.*, 2001; Gerasimenko, 2006a), was obtained only from the Sokyrnytsya 1-A site (published in Russian, Gerasimenko, 2006b). The stratigraphical subdivision of the Sokyrnytsya section was first fulfilled together with Zh. Matviishina (Usik *et al.*, 2006). Morphological features of the palaeosols at Ruban' have been described in Kulakovska *et al.* (2018). The significant similarity of the Middle and Upper Pleistocene pedocomplexes at Korolevo 1, Sokyrnytsya 1-A and Ruban', which is demonstrated in this paper, allows their correlation and the environmental reconstruction for the Middle and Early Upper Palaeolithic in the Upper-Tysa Depression.

Material and methods. The Sokyrnytsya 1 site was discovered and excavated in 2000–2004 (Usik, 2001; Usik *et al.*, 2003–2004). The most important point Sokyrnytsya 1-A includes several archaeological levels and horizons of findings. The Middle Palaeolithic Ruban' site was discovered and excavated in 2005 – 2008 (Kulakovska *et al.*, 2018). The sites Sokyrnytsya 1 (48°7'55"N, 23°24'6"E, 230–240 m a. s. l.) and Ruban' (48°9'29"N, 23°11'18"E, 206–213 m a.s.l.) are located in the high Early Pleistocene terraces of the Tysa River within the Upper-Tysa Depression. The latter, protected from both sides by the ridges of the Volcanic Carpathians, is one of the warmest parts of the Transcarpathia, with the very high annual precipitation (1000–1500 mm). The modern soil cover consists of Albic Luvisols and Gleyic Fluvisols, and the natural vegetation is represented by oak-beech woods and mesophytic herbal associations. The local

vegetation of the sites is completely changed by human activity, and it consists of forbs and grasses, surrounded by bushes and ferns. The lithopedostratigraphic descriptions of both sections have been carried out according to the Quaternary stratigraphic framework of Ukraine, based on the stratigraphy of Korolevo 1 as the reference site (Adamenko *et al.*, 1989; Haesaerts *et al.*, 2007). The ¹⁴C dates in this paper are uncalibrated.

46 samples, taken with the interval 5 cm from the Sokyrnytsya I-A section, have been palynologically analyzed. The sample processing includes those steps: boiling in a 10% solution of HCl, disaggregation in a 15% solution of Na₄P₂O₇ in order to remove clay particles, removal of the secondary carbonates with HCl, boiling in a 10% solution of KOH to dissolve organic matter, treatment in a heavy liquid (CdI₂ and KI, specific gravity 2.0) in order to separate palynomorphs from silt particles. Despite the pollen frequencies were low in the majority of the samples, 100–200 palynomorphs were registered in each of them, and pollen preservation was good. Re-deposited palynomorphs were practically absent. Pollen grains were identified with the aid of pollen atlases (Kupriyanova, Alyoshina, 1972, 1978; Bobrov *et al.*, 1983; Reille, 1995). Pollen diagram is represented in Fig. 2, and these abbreviations are used: AP – pollen of trees and shrubs, NAP – pollen of herbs, grasses and sedges, and PZ – pollen zone. The reconstructions of past vegetation are based on the methodological principles elaborated by V. Grichuk (1989) and N. Bolikhovskaya (1995). Their studies of surface samples have proved the under-representation of palynomorphs of broad-leaved trees in pollen assemblages, which allows the reconstruction of domination of broad-leaved trees in the vegetational cover if ≤ 20% of their pollen is counted (from AP sum) in the corresponding pollen spectrum.

The large thickness of deposits (including loess units) at Korolevo 1 is controlled by its location in the palaeogully cutting the old terrace. At Sokyrnytsya 1-A and Ruban', located on the flat (or gently sloping) terrace surfaces, sedimentation rates during the Quaternary were much lower, and, thus, the non-soil units were significantly re-worked by translocation pedogenic processes, as it also has been shown in the other areas of Ukraine (Gerasimenko, 2006a). This is the reason why the material, which is visually related to the Bt soil horizons, was, in fact, formed during the preceding cold phase (judging from its pollen spectra of a periglacial type, or by the findings of the Palaeolithic material). The comparison of palaeopedological and pollen data is most important for the proper palaeoenvironmental interpretation. In this respect (as no pollen diagram is available for the Korolevo 1), the

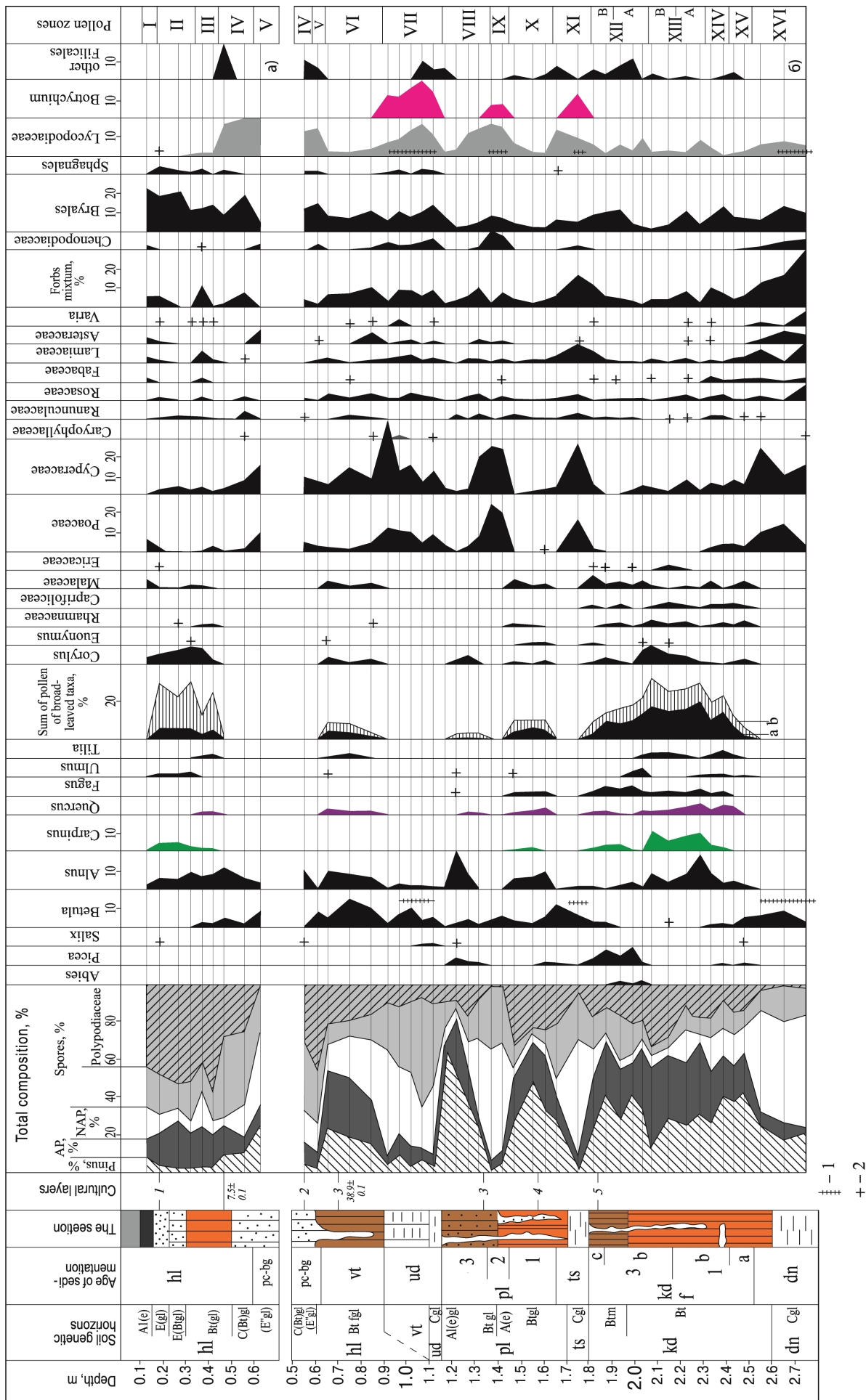


Fig. 2. Pollen diagram of the Sokymytsya 1-A site: a) excavation 3, b) excavation 1. Legend: 1 – pollen of *Betula* sect. *Nanae* et *Fruticosae*, 2 – spores of arcto-boreal and arcto-alpine species of *Lycopodiaceae*. The curves inside the Fig.: a – percentages counted from the total sum, b – percentages counted from the AP sum.

Sokyrnytsya 1-A site is the key section for the studied area.

The Holocene (hl). In both Sokyrnytsya 1 site and the majority of the Ruban' sections, the Holocene unit is partly truncated. The complete profiles of the Holocene soils were studied in a few sections (e.g. the excavation 3 at Sokyrnytsya 1-A, Fig.3a), where these soils are undisturbed and represented by a pedocomplex from the upper Luvisol and the lower Albic Luvisol. Pollen assemblage of the A1(e) horizon of the Luvisol corresponds well to the local surface pollen sample and the modern vegetational composition. The characteristic features are the predominance of spores (57-74%, mainly of Polypodiaceae), the presence of pollen of herbs and bushes, and very low percentages of broad-leaved trees (PZ I, Fig.2a). The pollen assemblages of soil genetic horizons E(gl), E(Btgl) and the upper part of Bt(gl) are also dominated by fern spores, but the AP increases, and it includes pollen of broad-leaved taxa, particularly *Carpinus* and *Corylus* (PZ II). A few artifacts of cultural level 1 are found *in situ* in the upper part of E(gl) horizon only in the excavation 3 of Sokyrnytsya 1-A. The absence of diagnostic features in these artifacts and their small number does not allow the cultural assignment of this level.

In the lower part of the Bt(gl) horizon, pollen of *Quercus* and *Tilia* is more abundant than *Carpinus*, and some increase in NAP is observed (PZ III). The Egl horizon of the Holocene Albic Luvisol (Cgl horizon of the upper Luvisol) has abundant Fe-Mn punctation, and it includes PZ IV and PZ V. In PZ IV, pollen of broad-leaved trees disappeared, *Alnus* dominates the AP, and Lycopodiales became significant among the spores. In PZ V, NAP, consisting mainly from Poaceae and Cyperaceae, dominates; AP includes *Pinus sylvestris* and small-leaved trees; Polypodiaceae spores disappear. PZ IV and V (Fig. 2b) are represented in the same soil genetic horizons in the excavation 1 at Sokyrnytsya 1-A (Fig.4b) where the upper part of the Holocene pedocomplex is disturbed by human impact.

The striking difference between PZ IV and V indicates that the material of the lower part of Egl horizon of the Albic Luvisol was formed under different climatic conditions than its upper part, and, thus, it has different age. It is confirmed, on one hand, by the ^{14}C date $7,560 \pm 150$ yrs BP (Usik *et al.*, 2004), indicating the Holocene age of its upper beds, and, on the other hand, by the presence in its lower beds of the cultural level 2 which includes the Upper Palaeolithic artefacts. The small collection from this level and the

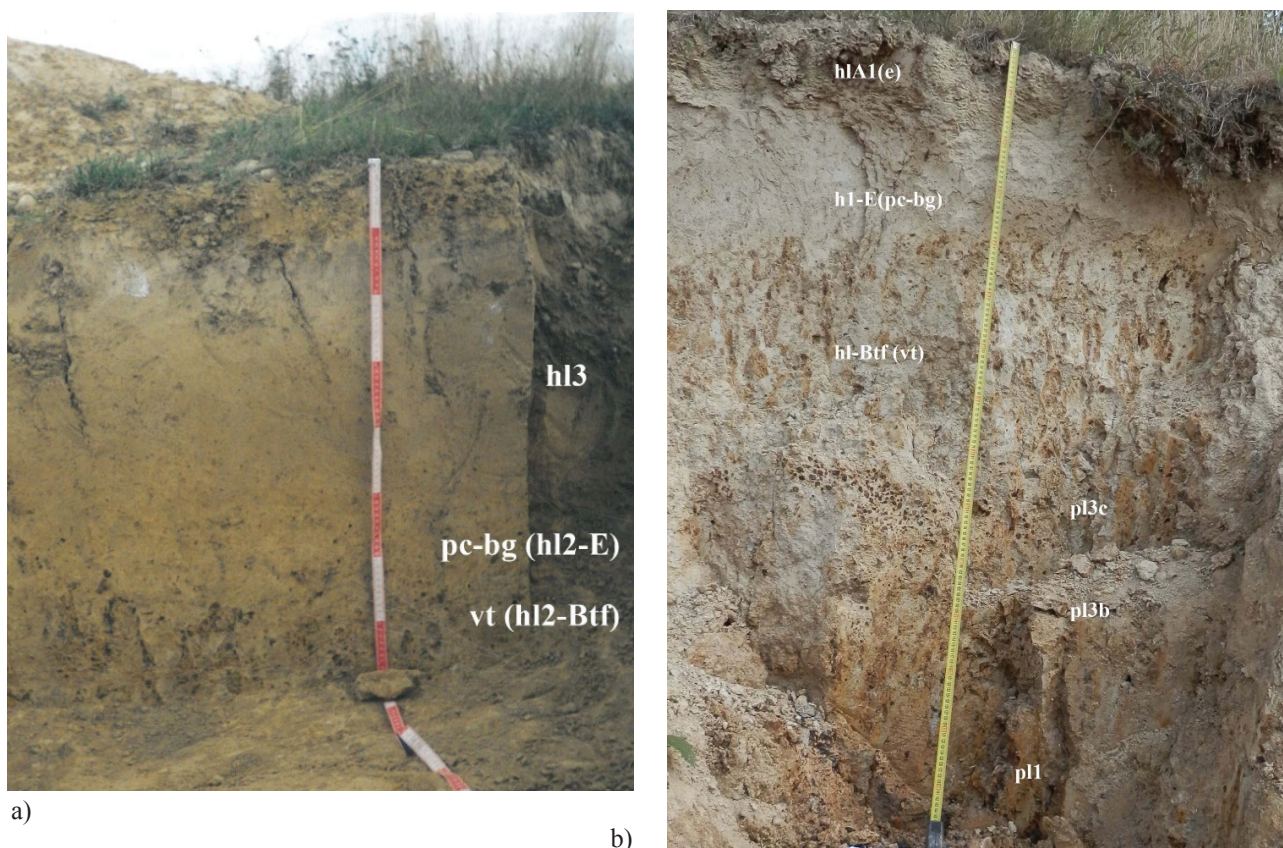


Fig. 3. The sections of the Holocene and the upper part of Upper Pleistocene deposits, undisturbed by human impact: a) the upper part of the Holocene pedocomplex in the excavation 3 at Sokyrnytsya 1-A. The Btff horizon of the lower Holocene soil is formed in the material of Vytachiv unit; b) the Holocene and Upper Pleistocene deposits in the excavation of the middle part of the slope at Ruban'.

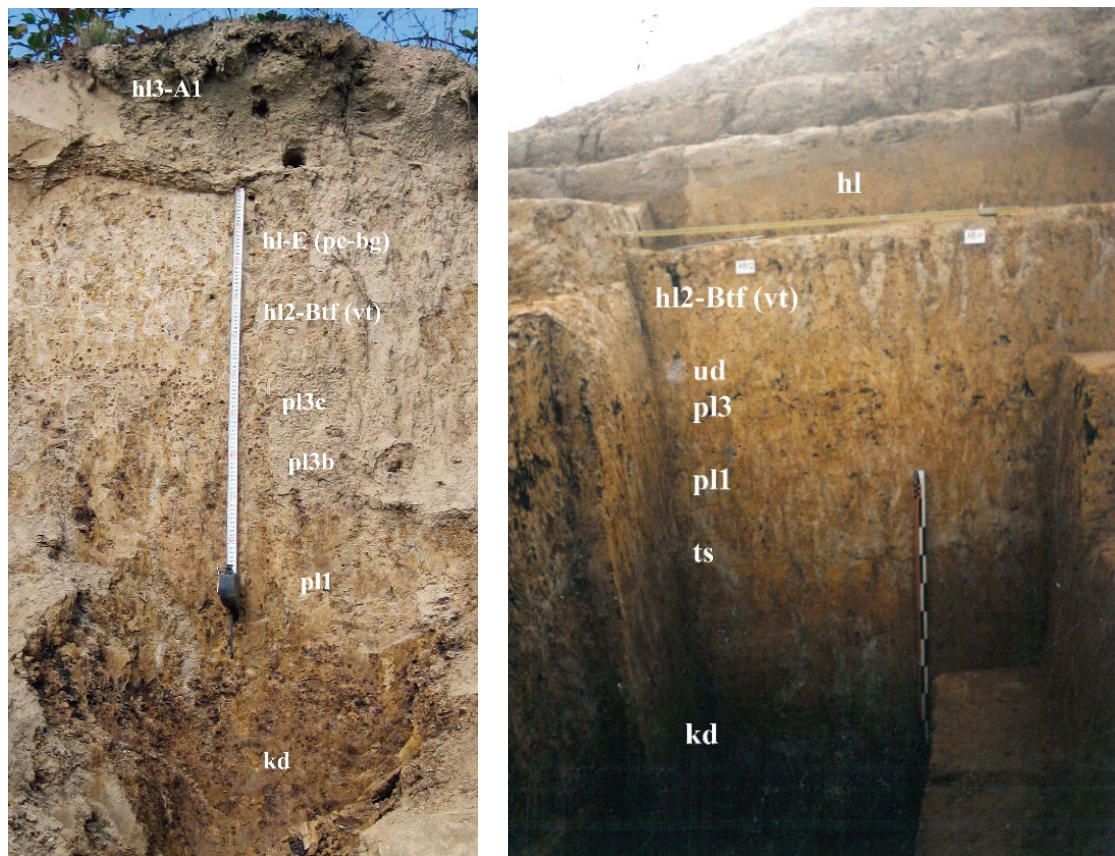


Fig. 4. The Holocene and Upper Pleistocene deposits: a) at Ruban' (the upper part of the slope); b) at Sokyrnytsya 1-A (the flat surface of the terrace, truncated from the top).

absence of diagnostic features in the artefacts do not allow its cultural attribution. ***Prychernomorya-Bug (pč-bg) units.*** The domination of NAP, the occurrence of only boreal trees in the AP of the lower part of the Egl horizon, the presence of frost fissures, deeply dissecting the underlying Vytachiv unit both at Sokyrnytsya 1-A and Ruban' (Fig. 3, 4), and the presence of the Upper Paleolithic artefacts allow the suggestion that this material was formed under the climate of a stadial. During the Holocene, it was affected by eluvial pedogenic processes. At the Upper Paleolithic site Shayan 1, the similar lithostratigraphic unit has been ^{14}C -dated between $19,850 \pm 400$ and $27,700 \pm 800$ ka BP (Usik *et al.*, 2004). At Korolevo 1, the primary loess-like carbonate material is preserved in places at this level, and it is TL-dated to the Upper Pleistocene (Adamenko *et al.*, 1989). Such ages prove that the primary material was deposited during the 'pc-bg' times. The similarity in the lithomorphology allows the suggestion that the same horizon at Ruban' also was formed during these times.

At Korolevo 1, Sokyrnytsya 1-A and Ruban', ***Vytachiv (vt) unit*** is transformed by the translocation processes during the formation of the Holocene Albic Luvisol, and visually it represents Btfgl genetic soil horizon. The characteristic features of this brown

horizon is the presence of a huge amount of small Fe-Mn nodules (in the upper part also Mn films), the marble-like colouration and the combination of prismatic structure and platy texture. Films of Mn hydroxide on the horizontal plate surfaces indicate that the lamination was formed before mobilization of manganese in the humid Holocene climate, and, thus, during the cold 'pč-bg' times. It is confirmed by the irregularity both of the upper boundary (see above) and the lower transition of the unit ('tongues' filled with the soil material). In the main part of the Vytachiv soil (0.6-0.8 m), AP dominates (PZ VI), consisting mainly of *Betula* and *Alnus*, though pollen of *Quercus*, *Tilia* and *Corylus* occur. The percentages of spores (28-31%) are much lower than in the overlying deposits. The NAP includes mainly Cyperaceae and forbs. The pollen data indicate that these deposits were formed during an interstadial. The charcoal from the **cultural layer 3** (0.6-0.85 m at Sokyrnytsya 1-A) yielded eleven ^{14}C dates indicating its age between $38,200 \pm 450$ and $42,150 \pm 500$ ka, the average date of $38,800 \pm 110$ (Usik *et al.*, 2004). This allows the suggestion that it was formed during the Middle Vytachiv interstadial, dated 38-36 ka uncal ca BP (Gerasimenko, 2006a). Despite the Vytachiv soils at Ruban' and Sokyrnytsya 1-A are morphologically similar, their secondary transformation by the Holocene illuvation processes

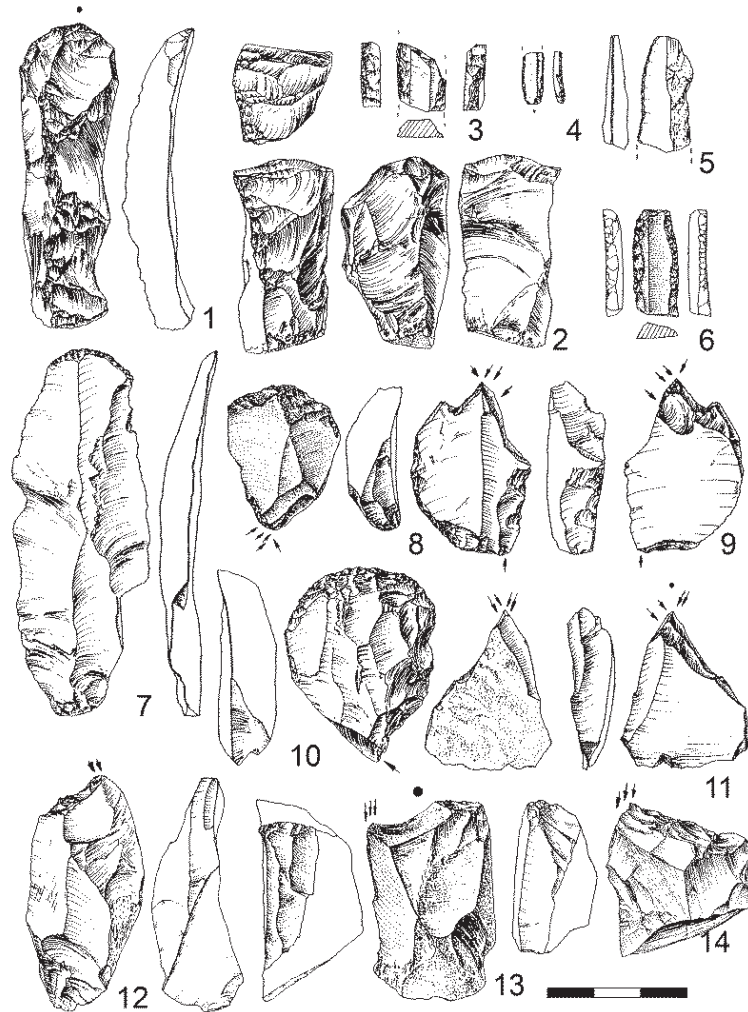


Fig. 5. Sokyrnytsya 1-A, cultural level 3, the Early Upper Paleolithic, tools: 1, 2, 7 – end scrapers; 3-6 – microliths, 8, 10 – end scrapers/burins; 9, 11-14 – burins.

allows the presumption that the different interstadial (or interstadials) of the Vytachiv time might be represented in this level at Ruban'.

In the cultural level 3, mainly quartzite pebbles were used for reduction. In the collection, there are samples of andesite raw material, typical for the Early Upper Palaeolithic at Korolevo 1. The primary flaking is focused on production of blades from parallel volumetric cores (cylindrical, sub-cylindrical, pyramidal, *etc.*), mainly with a soft hammer. The collection includes the typical crested blades and core tablets. Burins predominate over end scrapers in the tool kit. Dihedral burins are more common than those on truncation. Burins are often multifaceted, made on massive blanks. End scrapers are represented by simple type, on retouched blades and flakes, as well as those combined with burins. The Aurignacian forms are rare and atypical. Dufour bladelets are absent. Microliths are made on bladelets and microblades with lateral and bilateral dorsal retouch. Thus, the level 3 represents the specific Upper Palaeolithic industry.

The lower part of Vytachiv unit at Sokyrnytsya 1-A (0.8-0.9 m) includes PZ VII (AP 6-20%) which strongly differs from PZ VI by the increase in NAP (21-59%) and spores (35-66%), the disappearance of pollen of broad-leaved taxa and the presence of palynomorphs of arcto-alpine and arcto-boreal species (*Betula* sect. *Nanae* et *Fruticosae*, *Lycopodium lagopus*, *Diphazium alpinum*, and, particularly, *Botrychium boreale*). Pollen of Chenopodiaceae first became noteworthy. The pollen assemblage from the underlying **Uday (ud) unit**, represented by a thin light-grey loam, belongs to the same PZ VII. Thus, the lower beds of Vytachiv unit (the Bt-Cgl soil horizon) were formed during a stadial climate of the Uday time, and they have been transformed by pedogenic processes later. The network of long fissures-in-row, filled in with the Uday material, dissects the underlying Pryluky soils both at Sokyrnytsya 1-A and Ruban'. The TL-data from the lower part of the same soil at Korolevo 1 are around 60 ka BP (Adamenko *et al.*, 1989) that fits to chronological attribution of the Uday unit in Ukraine.

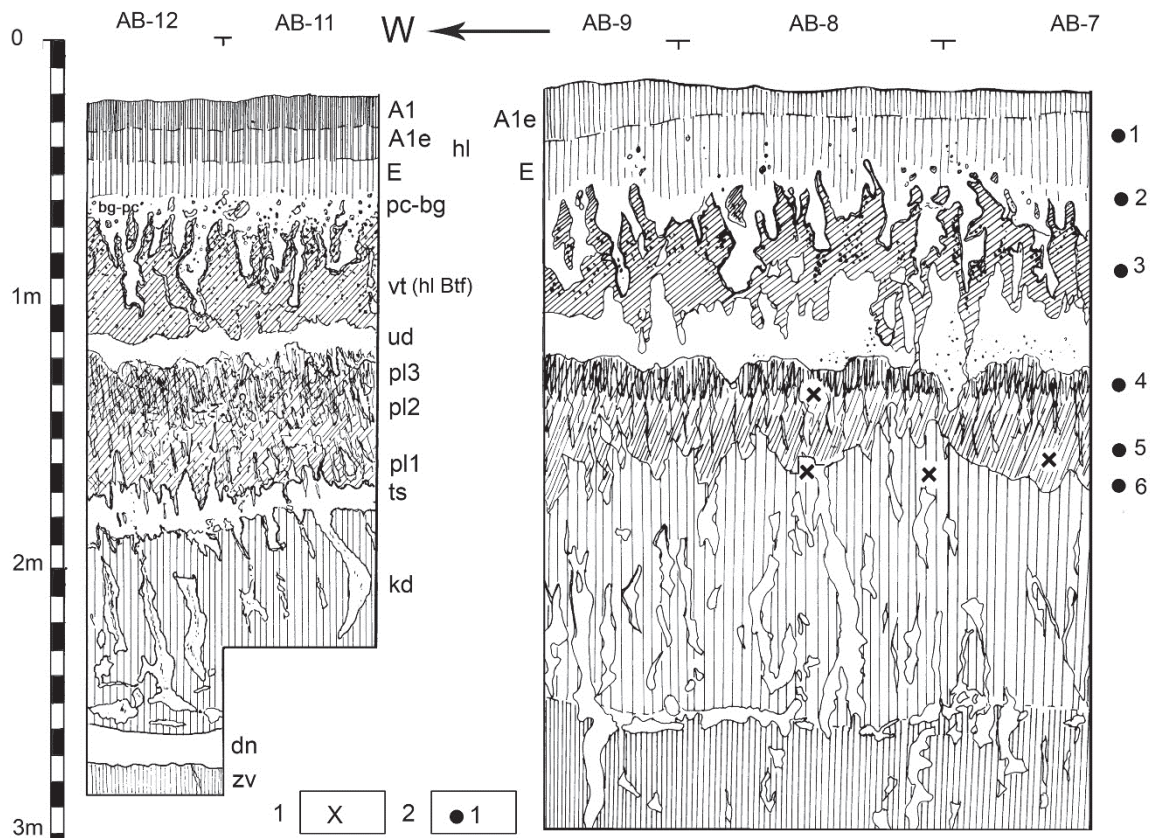


Fig. 6. Sokyrnytsya 1-A, excavation area 1, northern wall, stratigraphical position of cultural levels. 1 - position of artifacts in the section; 2 – position of the cultural levels.

Pryluky (pl) unit at Sokyrnytsya 1-A and Ruban' is a pedocomplex, consisting of two soil subunits ('pl₃' and 'pl₁'), separated by a thin non-soil loam ('pl₂'). The level of ground wedges is connected with the 'pl₂' subunit (see Fig. 4). Subtypes of the Pryluky Luvisols depend on their position in palaeorelief but, in general, these soils are brighter (with reddish-brown tints) than the overlying deposits, and strongly mottled in colour (black manganese spots alternate with ochre iron-hydroxide and bluish-gley spots). At the Sokyrnytsya 1-A site, which is located on the relatively flat surface and topographically higher than the Ruban' site, the Pryluky soils have short profiles and very high content of clay particles. These factors caused the strong surface moistening of the upper beds of the soil 'pl₃', which is reflected in the abundance of thick manganese films on the ped surfaces. The short-profile Pryluky soils were observed only in the topographically highest excavation from eleven of them in the Ruban' geological profile, stretched along the gentle slope to the gully, which dissects the terrace. Downslope, because of the increase in sedimentation rates, the thicknesses of Pryluky unit became larger, particularly of 'pl₃' subunit, which consists there of two soils – 'pl_{3c}' and 'pl_{3b}'. The position on the slope

provided the better water drainage of these soils than at Sokyrnytsya 1-A, and, thus, manganese hydroxides are concentrated in the abundant small nodules at the top of the thin 'pl_{3c}' Cambisols. The 'pl_{3b}' soils are the thicker Luvisols, with the darker A1(e) horizon and the bright-brown Btf horizon, and with discrete relatively small Mn films. In places, the 'pl₃' subunit is completely dissected by wedges, filled in with the Uday material.

At Sokyrnytsya 1-A, PZ VIII (1.15-1.4 m) from the 'pl₃' subunit has a strong predominance of AP (68-82%). The majority of the AP belongs to *Pinus sylvestris*, though *Alnus* is rather abundant (up to 20%) and *Picea* appears (1-4 %). Only a few pollen grains of broad-leaved taxa (*Quercus*, *Ulmus*, *Fagus* and *Corylus*) occur, whereas in the uppermost level of the subunit, only pollen of boreal trees is present. Polypodiaceae dominate spores, and palynomorphs of arcto-boreal species disappear. Such pollen assemblage is typical for a cool interstadial. The artifacts from the depth 1.20-1.40 m mark cultural level 4. Their morphological features are associated with the Middle Palaeolithic techno-complex.

The Middle Palaeolithic cultural level at Ruban' is located in the top layer of the 'pl_{3c}' soil (Fig. 7). The

archaeological collection from this level contains 953 artefacts, among which quartzite raw material predominates. The other raw materials are argillite and, more rarely, andesite. The collection includes cores, flakes, blades, tools, chips and fragments, indicating a complete cycle of primary flaking and manufacture of tools, which took place directly in the location. The blank production, based on radial, sub-crossed, orthogonal and Kombeva's methods, was used sporadically. These systems of blank production resulted in domination of short and thick flake, triangular in a cross-section. These flakes were used as a main blank for the majority (52%) of tools. Blades are rare and, obviously, were produced unintentionally. The striking platforms of blanks are mainly thick, cortical or unprepared.

The collection of tools (5.8% from the sum of artifacts) demonstrates a definite dominance of the side scrapers (52%), which are usually represented by convex – simple (19%), diagonal (16%) and transverse (4%). The working edge of tools is frequently formed by the scaled stepped retouch (the so-called «Quina», or «Semi-Quina»). Many tools have the so-called «back», often natural, which presents a striking platform, or an edge of a core. These types of scrapers are very similar in design (Fig. 8). The other types of side scrapers, such as déjeté, double and ventral, occur very rarely. The collection also includes denticulates (4%), notches (7%) and retouched flakes (27%). Thus, the Ruban' site technology can be described as non-Levallois, non-blades, non-faceted. The analysis



Fig. 7. Ruban': a) position of the subunit 'pl_{3c}' in the excavation on the slope, which was truncated by the quarry; b, c - position of the Middle Paleolithic cultural level in the excavation of the archaeological site (also truncated); d) the Middle Paleolithic: scrapers.

of the typology (selection of the blanks, secondary flaking, the ratio of types of tools) allows the assignment of the collection at the Ruban' to a circle of the Middle Palaeolithic industries of the Quina type.

The 'pl₂' loam at Sokyrnytsya 1-A includes PZ IX which differs from PZ VIII by the sharp decrease in AP (5-11%) compensated by the increase in NAP (58-64%). Pollen of *Picea* and broad-leaved taxa is absent. The NAP consists mainly of Poaceae and Cyperaceae, though Chenopodiaceae pollen also appears. Arctoboreal species of Lycopodiales and *Botrychium boreale* dominate the spores, and Polypodiaceae are not present. The 'pl₁' Luvisol at Sokyrnytsya 1-A is not strongly enriched in manganese segregations, but in the soils at Ruban', their A1 horizons include a huge amount of Fe-Mn concretions, which are larger and more frequent than in the Vytachiv soils. The better drainage of these Luvisols at Sokyrnytsya 1-A than at Ruban' might be explained by formation of the first ones on the less clayey Tyasmyn loams which are absent at Ruban' sections. At Sokyrnytsya 1-A, PZ X (1.45-1.65 m) from the 'pl₁' soil is dominated by AP (69-50%), and the spore percentages are larger than in the 'pl₃' soil (27-51%). *Pinus sylvestris* predominates the AP (26-47%), but the percentages of pollen of broad-leaved taxa are higher than in the 'pl₃' soil – *Quercus* and *Fagus* (each 2-4%) and a few grains of *Carpinus* and *Ulmus*. Pollen of bushes are diverse – *Corylus*, *Euonymus*, *Frangula* and arboreal Rosaceae. Polypodiaceae strongly dominate the spores. The cultural level 5 which includes the Middle Palaeolithic techno-complex is located at the depth 1.53-1.63 m.

Tyasmyn (ts) unit at Sokyrnytsya 1-A is a pale-grey loam (0.1 m thick) with irregular lower transition – narrow wedges (0,5 m in depth) and shallow pocket-like downward intrusions. The narrow wedges with gleyed non-soil material are also open from the level below the 'pl₁' soil at Ruban'. At Sokyrnytsya 1-A, the Tyasmyn loam includes PZ XI, which has a very low AP (up to 8%), represented mainly by *Betula* sect. *Nanae* et *Fruticosae*. The majority of NAP consists of Cyperaceae, Poaceae and Lamiaceae. The spores are dominated by arcto-alpine Lycopodiales and *Botrychium boreale*.

Kaydaky (kd) unit is represented in both sites studied by the thick Bt_f horizon of Luvisol (Fig. 4, 8). Ochre-brown colour of the soil indicates the high content of iron hydroxides that is typical for the warm facies of Luvisols. Glossy massive reddish-brown cutans of illuviation cover the surface of blocky-prismatic peds. Manganese punctuation is much less abundant than in the overlying deposits. The platy texture of the soils (up to the depth 0.6 m from their surface) is of particular interest. The lamellas intersect

gley spots in the soils, and, thus, they were formed as the result of cryolamination, which occurred after the pedogenesis. At Sokyrnytsya 1, the gley spots (up to 0.1 m in width, up to 0.4 m in length) are particularly prominent, and despite they frequently are vertical, their horizontal forms also occur, and there is no level from which they open systematically. Thus, they are not frost wedges or desiccation fissures. Most likely, they represent the development of gley processes in organic remains of the former tree roots.

All PZ from the Kaydaky soil at Sokyrnytsya 1-A are dominated by AP (50-69%). They are as follows (from top to bottom). PZ XII from the uppermost part of the soil differs by the presence of *Picea* pollen (up to 9%). It is subdivided into two subzones on the basis of presence of *Abies* and the higher percentages of pollen of broad-leaved trees in the lower part (PZ XII-A). Broad-leaved taxa are represented mainly by pollen of *Fagus* and *Carpinus*. Pollen of arboreal Rosaceae is most abundant among bushes. Bryales spores share dominance with Polypodiaceae, and NAP percentages are extremely low (4%). The Middle Palaeolithic level 6 is located at the top of Kaydaky soil (the depth about 1.8 m).

PZ XIII differs from PZ XII by the increase in pollen of broad-leaved trees (20%), *Alnus* (up to 18%), and the disappearance of dark conifers. PZ XIII is also subdivided into subzones – the upper one (XIII-B) has the maximum of *Carpinus* and *Corylus* pollen (both up to 12%), *Tilia platyphyllos* and Ericaceae are present, whereas in the lower PZ XIII-B, the decrease in *Corylus* is compensated by the increase in *Quercus* pollen. Palynomorphs of *Frangula* and *Viburnum* are noteworthy in both subzones, as well as high percentages of Polypodiaceae spores (up to 39%). The next PZ XIV has the lower percentages of AP and of pollen of broad-leaved trees (10-14%), compensated by some increase in NAP. In the AP, pollen of *Quercus* predominates (3-6%), pollen of *Carpinus*, *Fagus*, *Ulmus*, *Tilia* and *Corylus* constitute each 1-2%. PZ XV differs by the further decrease in pollen percentages of broad-leaved trees (2-6%), represented by *Quercus* (predominates), *Ulmus* and *Tilia*, by the disappearance of *Carpinus*, *Fagus*, and the presence of a few *Picea* pollen.

Dnieper (dn) unit is represented as a thin light-grey loam only at Sokyrnytsya 1-A, but both at Sokyrnytsya 1-A and Ruban', the underlying Luvisol of Zavadivka unit is distorted by the posterior cryogenic structures and textures of the Dnieper time (particularly by the platy textures). At Sokyrnytsya 1-A, the Dnieper unit includes PZ XVI. The pollen assemblage from the lowermost Bt-C horizon of the Kaydaky soil also belongs to this PZ. This indicates that the upper

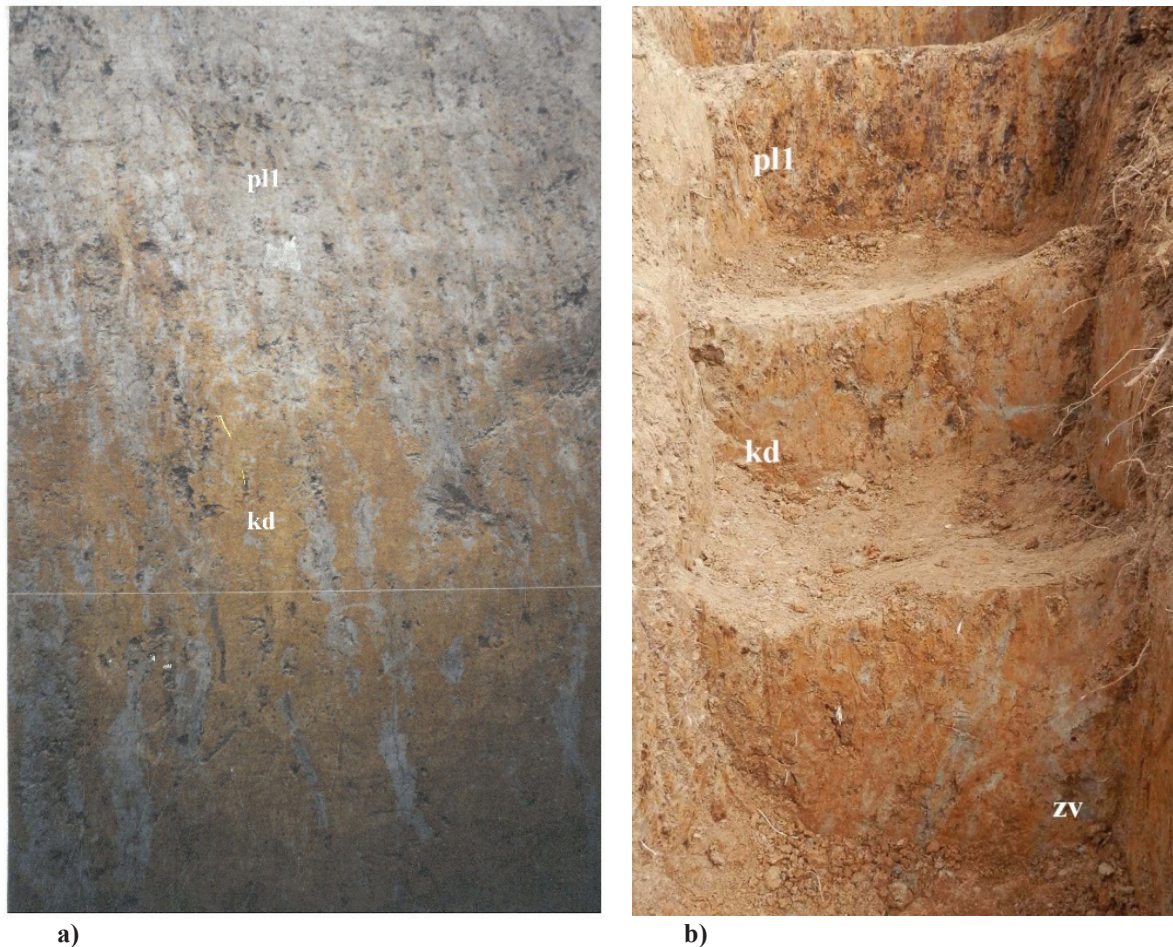


Fig. 8. The lower Pryluky and Kaydaky soils at Sokyrnytsya 1-A (a) and Ruban' (b).

beds of Dnieper unit were re-worked here by translocation processes of the Kaydaky pedogenesis. PZ XVI is dominated by NAP (54-59%) which includes forbs, Cyperaceae, Poaceae and few Chenopodiaceae. AP (23-31%) consists of *Pinus sylvestris* and *Betula* sect. *Nanae* et *Fruticosae*. The spores are dominated by Bryales and arcto-boreal species of Lycopodiales.

Interpretation. The Middle Palaeolithic first appeared in the Upper-Tysza Depression during the formation of the soil correlated by P. Haesaerts and L. Koulakovska (2006) with MIS 7. In Ukraine, the terrestrial equivalent of MIS 7 is regarded either as Kaydaky unit (Veklich *et al.*, 1993; Gozhik *et al.*, 2000; Lindner *et al.*, 2006), or as Potyagaylivka unit (Gerasimenko, Matviishina, 2007; Matviishina *et al.*, 2010). The latter was earlier considered as the uppermost soil of the Zavadivka unit *sensu lato* (Veklich *et al.*, 1993) because the Upper Middle Pleistocene soils in Ukraine frequently are represented by a single very thick pedocomplex, or by one welded soil. In Transcarpathia, the Middle Palaeolithic culture has been discovered in Zavadivka unit at Malyi Rakovets IV (Yamada and Ryzhov, Eds., 2015). At the Sokyrnytsya 1-A site (cultural level 6), the Middle Palaeolithic first appeared at the very end of the *Kaydaky*

time, when the formation of the interglacial Luvisols was finishing. The light pine woods, with ferns in the ground cover and arboreal Rosaceae in the undergrowth, dominated the landscapes. Spruce and a few broad-leaved trees (particularly beech) grew in wet locations. It was the end of the interglacial. The main features of pollen succession of this interglacial is similar to that of the Eemian (Mikulian), namely, the change of *Quercetum mixtum* by *Carpinetum* forest, the *Corylus* culmination, the appearance of *Abies* and *Picea* at the transition between the late-temperate and post-temperate stages of the interglacial. The Kaydaky soils both at Sokyrnytsya 1-A and Ruban' show morphological features characteristic for the much warmer climate than during the formation of all overlying soils. This facts and stratigraphical position of this interglacial below the two interstadials, palynologically determined within Pryluky unit, confirms the suggestion that Kaydaky unit is a correlative of the Last Interglacial (marine substage 5e), as it has been proposed earlier (Rousseau *et al.*, 2001; Gerasimenko, 2006; Matviishina *et al.*, 2010; Haesaerts *et al.*, 2016). The other suggestion exists on correlation of Kaydaky unit with MIS 7, and Pryluky unit with MIS 5 (Veklich *et al.*, 1993; Gozhik *et al.*, 2000;

Lindner *et al.*, 2006). At the sections studied in this paper, Pryluky unit is represented by the two interstadials, which cannot be compared with Kaydaky unit by the level of development of pedogenesis and by the abundance in pollen of broad-leaved taxa. The vegetation of the last interglacial in the Upper-Tysa Depression had its particular features, obviously controlled by the very high precipitation in this area (the extensive spread of beech) and high temperatures (the limited spread of fir and spruce). The spread of beech during the last interglacial in the Transcarpathia is also shown in the Korolevo 1 site (Pashkevich, 1984) and the Gat' section (Gerasimenko, Vozgrin, 2011).

The sharp reduction in arboreal vegetation occurred during the *Tyasmyn time*, when sedges, grasses and some forbs dominated the landscapes (PZ XI). Arcto-boreal and arcto-alpine species of birch, club-mosses and *Botrychium* grew extensively that indicates a periglacial climate. The development of cryogenic processes is reflected in frost wedges and very well expressed secondary platy cryotexture in the Kaydaky soils. This time span is correlated with the first stadial of the Early Glacial (substage 5d).

During the *formation of the lower Pryluky soil (pl₁)*, landscapes were dominated by mixed woods, which included pine, birch, broad-leaved taxa (oak, beech, hornbeam, hazel) and those bushes as spindle-tree, buck-thorn and arboreal Rosaceae (PZ X). Ferns formed the ground cover. Alder grew in the valleys. The Luvisols were the dominant soil type, and they were periodically intensely gleyed in the low relief positions (the Ruban' site). The climate was rather warm, as well as during the 1st interstadial of the Early Glacial in Central Ukraine, where it has been correlated with substage 5c (Roussaeu *et al.*, 2001; Герасименко, 2006a; Haesaerts *et al.*, 2016). The spread of broad-leaved trees during this interstadial occurred both in Eastern and Western Europe (Bolikhovskaya, 1995; Woillard, 1978). The existence of Middle Palaeolithic during this time is proved at Sokyrnytsya I-A (the cultural level 5). The Middle Palaeolithic cultural layer IV at Malyi Rakovets IV, located in the brightest reddish-orange part of the Btf horizon of the welded Pryluky-Kaydaky soil (Ryzhov *et al.*, 2015), might be also related to this time.

The *Middle Pryluky stadial (pl₂)* was characterized by almost complete disappearance of arboreal vegetation – only a few birches occurred (PZ IX). The open landscapes were occupied by sedges, grasses, arcto-alpine and arcto-boreal club-mosses and *Botrychium*. Chenopodiaceae first became noteworthy in the ground cover, whereas ferns did not grow. Depending on the relief, xeric coenoses alternated with cryomeso- or cryohygrophytic associations. The

periglacial climate of this 2nd stadial of the Early Glacial (the equivalent of substage 5b) was drier than that of the 1st stadial. In the Eastern Ukraine, xerophyte *Artemisia* dominated during this time (Roussaeu *et al.*, 2001). The soil formation ceased, whereas erosional and cryogenic processes developed intensely and deformed the underlying 'pl₁' soil, particularly in several localities at Ruban'.

During *formation of the upper Pryluky soils (pl₃)*, the landscapes were dominated by light pine woods, with an admixture of spruce, birch and a few broad-leaved taxa (hornbeam, oak, hazelnut and beech). Alder formed the flood-plain woods. The ground cover of the woods consisted of ferns and club-mosses (PZ VIII). At the end of the 'pl₃' time, broad-leaved trees disappeared. This interstadial was cooler than the preceding one that caused the decrease in evaporation and the appearance of excessive moisture in the grounds. As the result, mobilization of manganese occurred in the soils producing abundant Mn films on the structural plains of peds. The cooler climate that during the preceding interstadial is also found in the 'pl₃' soils of Central Ukraine which are correlated with the 2nd interstadial of the Early Glacial, the terrestrial equivalent of the marine substage 5a (Roussaeu *et al.*, 2001; Gerasimenko, 2006a). The climate was transitional from boreal to south-boreal, but at the very end of soil formation (the phase 'pl_{3c}'), it became colder, typically boreal. Pedological and pollen characteristics of the 'pl₃' soils correspond very well to those of the upper layer of the IInd soil at Korolevo 1 (Adamenko *et al.*, 1989; Pashkevich, 1984). Pollen data from this soil indicate the spread of boreal forest from pine (including stone pine), fir and larch. The Middle Palaeolithic existed at Sokyrnytsya 1-A (the cultural level 4) during the warmer part of this interstadial. The Middle Palaeolithic cultural level at Ruban' appeared at the very end of the 'pl₃' time – during its coolest phase 'pl_{3c}', at the transition to the cold Uday phase. In Central Ukraine (Roussaeu *et al.*, 2001; Gerasimenko, 2006a), the 'pl_{3c}' incipient soils are correlated with the weak Ögnon interstadials, established by Woillard (1978).

The Palaeolithic collections from the Kaydaky – Upper Pryluky units at Sokyrnytsya 1-A lack cores. At the same time, the flakes, produced by hard hammer, have scar patterns (centripetal, convergent, etc.), the shape and striking platforms usual for the Middle Palaeolithic. Single tools such as the transversal convex side scraper (level 4), the simple convex side scraper with a natural back (level 5) and a flake with inverse retouch (level 6) are also quite typical for the Middle Palaeolithic.

The Middle Palaeolithic industry at Ruban' oc-

curs in the top layer of the 'pl_{3c}' soil. The industry of this type was first ascertained in France (the site La Quina). A very specific type of tools of this industry is a massive scraper with the back and the Quina retouch. The working edge of this tool was formed by several rows of the retouch of a 'scaled' type, which reach a dorsal side of a flake. Thus, a working edge of this tool is stepped in a cross-section (Bordes, Bourgon, 1951). The industry of Ruban' site is completely analogous to those of the sites Korolevo I (level II), Malyi Rakovets' IV (level II) and the small collection from the Rokosovo. Nevertheless, at the Korolevo 1, this level is located in Uday unit, whereas at Malyi Rakovets', it is observed both in the very thin Uday unit (Stepanchuk *et al.*, 2013, Fig.20) and in the top layers of Pryluky unit (the same book, fig.34). Thus, the carriers of the described industry existed in the Upper-Tysa Depression and the adjacent low mountain ridges from the end of the Pryluky times through the following Uday times.

During the *Uday time*, the drastic cooling occurred. The spread of sedges and *Botrychium boreale* reached its maximum (PZ VI) in the open landscapes, where grasses, arcto-boreal and arcto-alpine species of club-mosses, some forbs and xeric Chenopodiaceae also grew. The coenoses were similar to those of the modern subalpine belt of the Carpathian Mountains but differed by some spread of steppe elements. The periglacial climate existed that is also confirmed by the growth of shrub birches and the development of cryogenic processes. At Korolevo 1, Uday unit is represented by a thin loess (Adamenko *et al.*, 1989) that indicates the development of aeolian processes in the region.

During the *Vytachiv interstadial*, represented in the Sokyrnytsya 1-A site (the Middle Vytachiv, around 38-39 ka BP), forest-steppe landscapes existed (PZ VI), with domination of south-boreal woods. The latter consisted mainly from arboreal birches and alder, with small admixture of pine and broad-leaved taxa (oak, lime and hazelnut). The forest ground cover was formed by ferns, and bushes became more abundant than during the pl₃ interstadial. Diverse forbs and sedges grew in the open landscapes. Judging from the pollen data, the climate was drier than during the Pryluky interstadials and this is confirmed by the presence of Fe-Mn nodules in the Vytachiv soil. They indicate a contrast changes in the precipitation (Veklich *et al.*, 1979), and, thus, there existed dry seasons during this interstadial. The pedological characteristics of the Vytachiv soil at Sokyrnytsya 1-A are well correlated with those of the Ist soil at Korolevo 1 (Adamenko *et al.*, 1989). According to the pollen data (Pashkevich, 1984), oak-pine forest dominated but the

spread of open landscapes points to some aridity. The Transcarpathian Lowland was covered by oak-pine woods, alder groves and meadows from sedges and forbs (Gerasimenko, Vozgrin, 2011). The presence of open landscapes favoured the protracted Early Upper Palaeolithic occupation at Sokyrnytsya 1-A (the main cultural level 3 of the site).

The rich in artefacts level 3 represents the non-Aurignacian industry, which is characterized by the typical Upper Palaeolithic tradition of blade production with the system of predominantly parallel unidirectional reduction, commonly used after the crest preparation on cores. Rejuvenation of cores with the so-called 'core tablet technique' and the usage of a soft hammer are frequent. The tool-kits are completely typical for the Upper Palaeolithic. At the same time, there are no cores and tool types ("carenated", "nosed", "Dufour"), typical for the Aurignacian, or their specific 'guiding' types that enables allocation of this collection to the individual culture. At present, the industry of the level 3 at Sokyrnytsya 1-A can be regarded as the 'unspecific' Early Upper Palaeolithic. The level 3 by its technical and typological indicators is correlated with level IVb at Kostenki 14 and the level Ia at Korolevo 1 (Monigal *et al.*, 2006; Usik *et al.*, 2006). The latter is located in the lower layers of Vytachiv unit. Thus, the described industry might exist in the studied area during the Early and Middle Vytachiv times. The last are correlated with Hengelo interstadial of Western Europe (Hammen, van der, 1995).

The next phase of environmental development, represented at Sokyrnytsya 1-A, belongs to a stadial with periglacial climate reflected in the strongest cryoturbations of the Vytachiv soils and in pollen data. The last indicates to domination of open landscapes with club-mosses, green mosses, sedges and some Chenopodiaceae (PZ V). At the beginning of the phase (judging from pollen from the material of the wedges infilling), ferns still grew but later on, they completely disappeared. Nevertheless, arboreal birches and alder persisted in the most protected habitats. As it had been shown above (the chapter 'Results'), this phase belongs to *the Bug-Prychernomorya times* (MIS 2). The pollen data from the Korolevo 1 site (Pashkevich, 1984) indicate that around 25 ka BP, the described area was occupied by sparse conifer woods (pine and larch). The absence of pollen of arcto-boreal and arcto-alpine vegetation, which would be expected for the Late Pleniglacial, might be explained by non-continuous sedimentation in the sites studied, where the deposits of the LGM had been truncated. The Upper Palaeolithic existed at Sokyrnytsya 1-A at the beginning of the described phase (the cultural level 2).

The Holocene. The first half of the Holocene (before 7.5 ka BP) was characterized by the spread of woods and development of intense translocation processes which lead to transformation of the material of ‘pc-bg’ and ‘vt’ units into the texture-differentiated profile of Albic Luvisol. At Sokyrnytsya 1-A, the formation of this soil was finished around 7.5 ka BP, or (more likely) this Albic Luvisol was truncated. The next phase of environmental development, palynologically detected in the Btf horizon of the upper soil of the Holocene pedocomplex in excavation 3 of Sokyrnytsya 1-A (PZ III), was characterized by the strongest spread of Polypodiaceae ferns, broad-leaved trees (oak, lime and hazelnut) on the terrace and alder groves in the valley. Such strong predomination of ferns (or herbs) over arboreal vegetation during the Holocene is normally typical for forest clearance (Kremeneckiy, 1991; Bezus’ko *et al.*, 2010), which in this case could occur at the second half of Atlantic (the Northgrippian). Thus, human impact on the vegetation started in the studied area approximately at the same time as in the belt of broad-leaved forest of the plain area of Ukraine.

The obtained results demonstrate multiple environmental changes in the studied area during the existence of Middle and Upper Palaeolithic which are well correlated with those established both in Eastern and Western Europe (Fig. 9). During the last glacial, the changes had a cyclic pattern – the alternation of the interstadials (with south-boreal and boreal climates) with the stadials (with periglacial climate) during. The deposits of the LGM and the coldest phase of the penultimate (Saalian) glaciation are not represented in the studied section, as well as the Early Atlantic optimum. Nevertheless, the morphological features of the last interglacial soil indicate that it was formed in the warmer climate than the ‘hl₂’ Albic Luvisol.

Conclusion. The area of the Upper-Tysa Depression is most important both for its archaeology and for palaeoenvironmental interpretations. For instance, concerning the Middle Palaeolithic, industries of the Quina type are quite common in Western Europe, but up to now they have been unknown to the east of the Carpathians (Kulakovska, 2003). The Early Upper Palaeolithic industry represented at Sokyrnytsya 1-A has the analogue in Eastern Europe (Kostenki XIV) but has not been described in Western Europe (Usik *et al.*, 2006). These facts prove the importance of the Transcarpathian Palaeolithic in the European context. The Late Pleistocene and Holocene environments of the Upper Tysa Depression are also rather specific, as there are not many areas in Europe that show its combination of high temperatures and high precipitation during the Pleistocene warm phases and the Ho-

locene. Intense translocation and gleying processes in the forest soils of the region frequently resulted in the transformation of the underlying non-soil deposits, those accumulated during Pleistocene cold phases. This led to the formation of the Pleistocene-Holocene sequences, consisting from welded soils, and this hampers the stratigraphical subdivision. The frequent position of archaeological sites on slopes, where erosional processes lead to the truncation of both paleosols and loesses, contributes to the difficulties in interpreting the stratigraphy. Thus, the profiles-transects of the Pleistocene deposits should be studied (like, for instance, eleven excavations at Ruban’). Pollen study is a necessary tool in stratigraphical subdivision and palaeoenvironmental reconstruction, as pollen assemblages indicate the primary environments, which existed prior to pedogenic processes transforming their parent rocks. The local palaeoenvironmental features are characteristic for the area studied, *e.g.* the formation of Fe-Mn concretions at the top of the majority of the palaeosols; the presence of thick films of manganese hydroxides, atypical for the Upper Pleistocene in other areas; the absence of Mollisols, characteristic for European plains; the spread of beech during the last interglacial and early glacial interstadials; limited growth of fir and spruce as compared to Central Europe, *etc.*). Nevertheless the main environmental phases of the Late Pleistocene in the Upper-Tysa Depression are well correlated with those in both Eastern and Western Europe (Fig.9).

In the sites studied, Middle Palaeolithic first appeared at the very end of the last interglacial, pollen succession of which is found in Kaydaky unit, represented by the most well developed Luvisol (of the warm facies) in the section. At that time, sparse pine woods included also some spruce and deciduous trees (including broad-leaved taxa). The Middle Palaeolithic continued into the early glacial interstadials, palynologically determined in subunits ‘pl₁’ and ‘pl₃’. During the corresponding time intervals, mixed woods consisted mainly of pine, particularly during the second interstadial. Among the deciduous taxa, small-leaved trees dominated over broad-leaved. The small collections of artefacts from Middle Palaeolithic levels and the absence of indicative features in them does not allow their assignment to certain technological-typological complexes.

In the Upper-Tysa Depression, the absence of Middle Palaeolithic in Tyasmyn and Uday units, and in Middle Pryluky subunit which were formed in open periglacial landscapes (beneficial for the Middle Palaeolithic in the other regions of the plain area of Ukraine), could be connected with the very high humidity and the very thick winter snow cover. In the

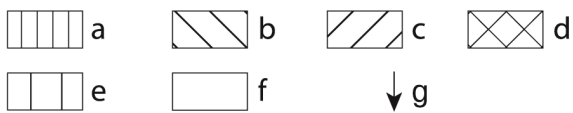
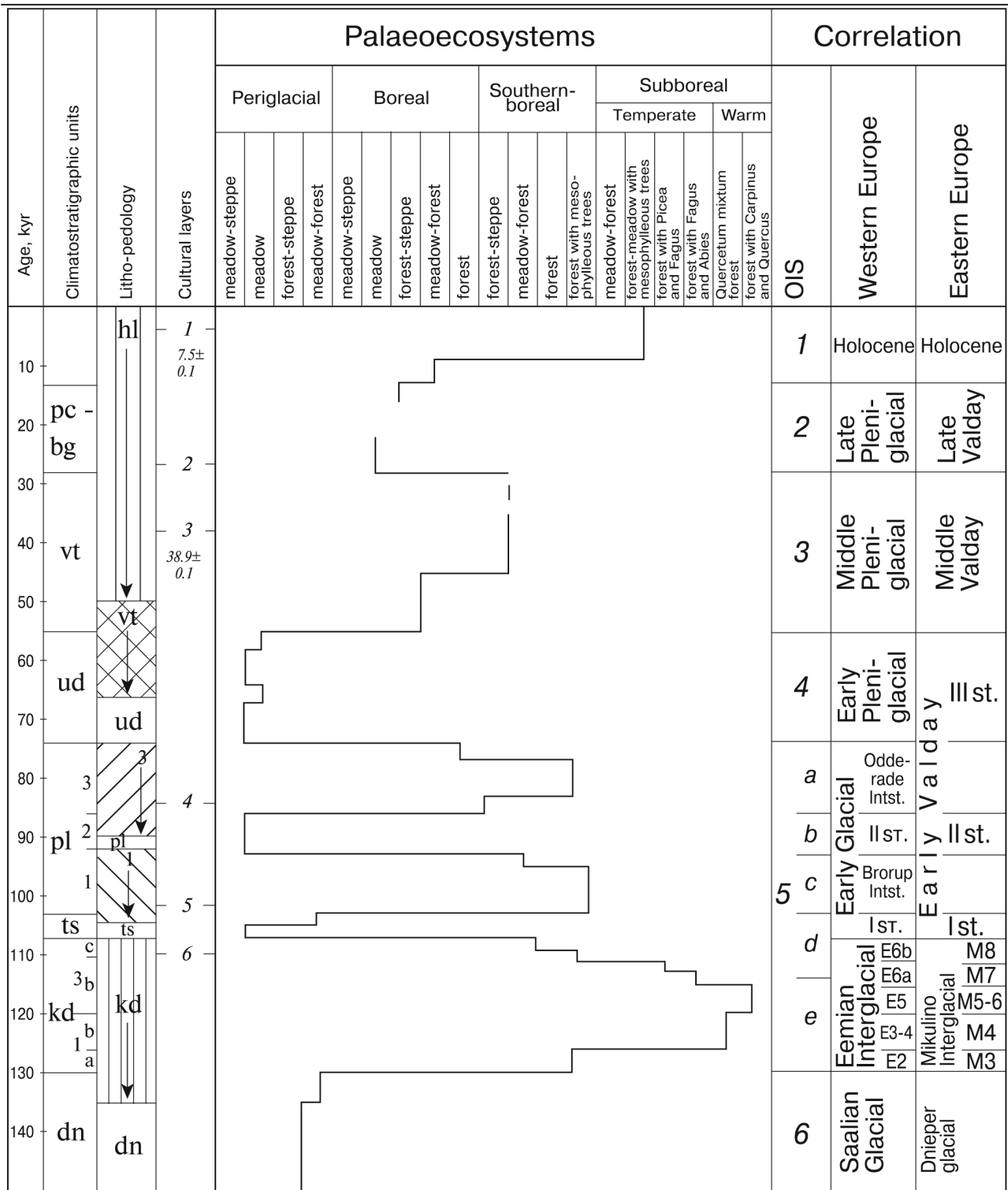


Fig. 9. Environmental changes in the Upper-Tisa Depression during the Late Pleistocene and Holocene (the study case of the Sokyrnytsya 1-A site) and the correlation with the glaciochronological frameworks of Western and Eastren Europe. Legend: a – Luvisol of warm facies, b – Luvisol of temperate facies, c – Gleyed Luvisol of boreal facies, d - Cambisol, e – Albic Luvisol, f – non-soil loam, g – translocation processes (modified from Gerasimenko, 2006) .

topographically higher and better drained localities (at Korolevo 1 and Malyi Rakovets’ IV), the Middle Palaeolithic artefacts are found in the Uday unit. At the very end of the substage ‘pl₃’, the horizon of the

Fe-Mn concretions indicates frequent dry seasons. During this time, the Quina Middle Palaeolithic culture existed both in the Upper-Tysa Depression and on adjacent mountain ridges.

During early and mid Vytachiv times, the reduction of woodland was balanced by the spread of mesophytic steppe. In the woodland, small-leaved trees dominated over pine and broad-leaved trees (mesophilous hornbeam and beech were absent). Judging from the last fact and the greater extent of herbs compared to ferns, the climate of the mid Vytachiv times was better for occupation by Palaeolithic people. Early Upper Palaeolithic (non-Aurignacian) culture of an unspecific type existed around 38 - 39 ka BP that has analogues only in Eastern Europe (Kostenki XIV). In the open landscapes at the beginning of cold 'pc-bg' times, Upper Paleolithic cultures existed in the Upper-Tysa Depression, but at Sokyrnytsya 1, artefacts are rare and do not allow their assignment to a specific cultural type.

During the Atlantic (the Northgrippian), well-developed Albic Luvisols could be formed only under woodland, but at the end of this period, forest clearance lead to the spread of ferns. The second half of the Holocene (the Meghalyan) was marked by the appearance of hornbeam in the oak-lime woods, whereas translocation processes still were active in the soils. During the formation of a humus horizon, the spread of meadow and mesophytic steppe associations and the further reduction of the forests in the studied area indicate the increase in human impact.

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