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V. N. GLADILIN

THE KOROLEVO PALAEOLITHIC SITE: RESEARCH METHODS, STRATIGRAPHY

SUMMARY — The multi-layered Palaeolithic site Korolevo, in the Soviet Transcarpathia appears to be one of the most important sources for studying the problems of the Palaeolithic of the south-east of Central Europe. In the course of many years of complex research into this unique site there was found a 12 m thick cover of deluvial loams with seven paleosols and with the underlaying alluvium of the 100—120 metre terrace on the left bank of the Tisa River and 16 cultural-chronological complexes (stone industry horizons): 7 Acheulian, 7 Mousterian and 2 of the initial phase of the Upper Palaeolithic. These were dated thanks to the use of micromorphological, palaeopedological, lithologo-mineralogical, palaeomagnetic, thermoluminiscent, palynological and palaeontological methods from Günz to Würm 2 of the French stratigraphic scheme. The massive occurrance of archaeological materials (in total more than 70 000 artifacts) offer a unique opportunity for studying the often repeated environmental changes in the Eopleistocene in the south-eastern part of Central Europe. Special focus should be concentrated on the evolution of the stone tool technology and on the collection of industries of this culturally unique Early Palaeolithic settlement. This all can be followed during a long section of time ranging from Acheulian to Mousterian and from Mousterian to Upper Palaeolithic.

KEY WORDS: USSR — Transcarpathia — Korolevo — Pleistocene — Stratigraphy — Chronology — Palaeolithic.

All papers of Soviet authors in this issue are based more or less on the materials of the multi-layered palaeolithic site Korolevo, in Soviet Transcarpathia. This is easy to understand. The Korolevo site appears more and more as a basis for the study of the contemporary palaeolithical science. The point is, however, that the existing information appears in preliminary publications only. It seems therefore to be purposeful to give here at least a general description of the site, with special regards to the methods of its research, and finally to its stratigraphy.

The site was discovered by V. N. Gladilin in 1974, and since then continue annual expeditions of the Ukrainian Academy of Sciences headed by him. Since 1976 the expedition realized the research in co-operation with the State University of Uzhgorod.

FIGURE 1. *The situation of the Korolevo site. A political-administrative sketch.*

The site was discovered in the region of the so-called Khust Gate between the towns of Vinogradovo and Khust, in the vicinity of the village Korolevo. The region of the Khust Gate is one of the most picturesque corners of the Soviet Transcarpathia. The Tisa River after breaking through the Vihorlat-Gutinian Ridge enters the Middle-Danubian (Hungarian) Lowlands. Along the road from Vinogradovo to Khust between the villages Malaya and Velkaya Kopanya there is an excellent view of the surrounding terrain. On the right, lower along the flow of the river we can see Chernaya Gora (Black Hill) covered with beech woods and of an absolute height of 568 m above the sea level. It is a long extinct volcano whose massif protects the area against the air currents from north-east, securing thus a mild microclimate for the region. On the left, upstream behind the village Rokosovo and behind the stone quarries in its south-eastern end, towers one of the highest peaks of the Vihorlat-Khust Ridge (873 m). On the opposite (left) bank of the Tisa, on a solitary extinct volcano we can see the white ruins of a former hunting-lodge of the Hungarian Kings in Hungarian called "Király Háza" ("The Kings's House"). This place-name appears also in the Ukrainian name of the village situated beneath the hill (Zamkovaya Gora — "Castle Hill") with the hunting-lodge ruins (Korolevo — "The King's"). The village has been connected with other village against the flow of the river, with the village Veryatsya. At its north-eastern margin begins the range of the foothills along the Tisa River, from the south to the north. It forms a 100—120 m high neck of land, the so-called Kopanyskaya Terrace (VII[th] above the flood plain). The terrace in the region of the Khust Gate has a wide terrace bench and a thin boulder bed in the vestige-bedding on the left bank of the Tisa, in the surroundings of Korolevo, and a many metres thick boulder bed on the right bank, near the villages Malaya and Velkaya Kopanya. The southern end of the range with the three peaks — "Vinnichki", "Beyvar" and "Gostriy Verkh", are separated by gorges. In the past they formed the western slope of the Sor Mountain (Szárhegy — "Barren Mountain"), corresponding to the higher, 200 m high level of the terrace of the Tisa River. From here we can overlook the surroundings: the valley of the Tisa with its numerous dead arms and branches, the stately house in Korolevo, the village Korolevo, the not-too-high terraces on the south-east near the village Gorbki, the steep right bank with the stone quarries near the village Rokosovo, Chornaya Gora (Black Mountain) and the fortified settlement from the beginning of our era near the village Malaya Kopanyiya. Two of the northern peaks — "Gostriy Verkh" and "Beyvar" have been damaged by stone quarrying, the third and southernmost peak — "Vinnyichki" serves as a dump.

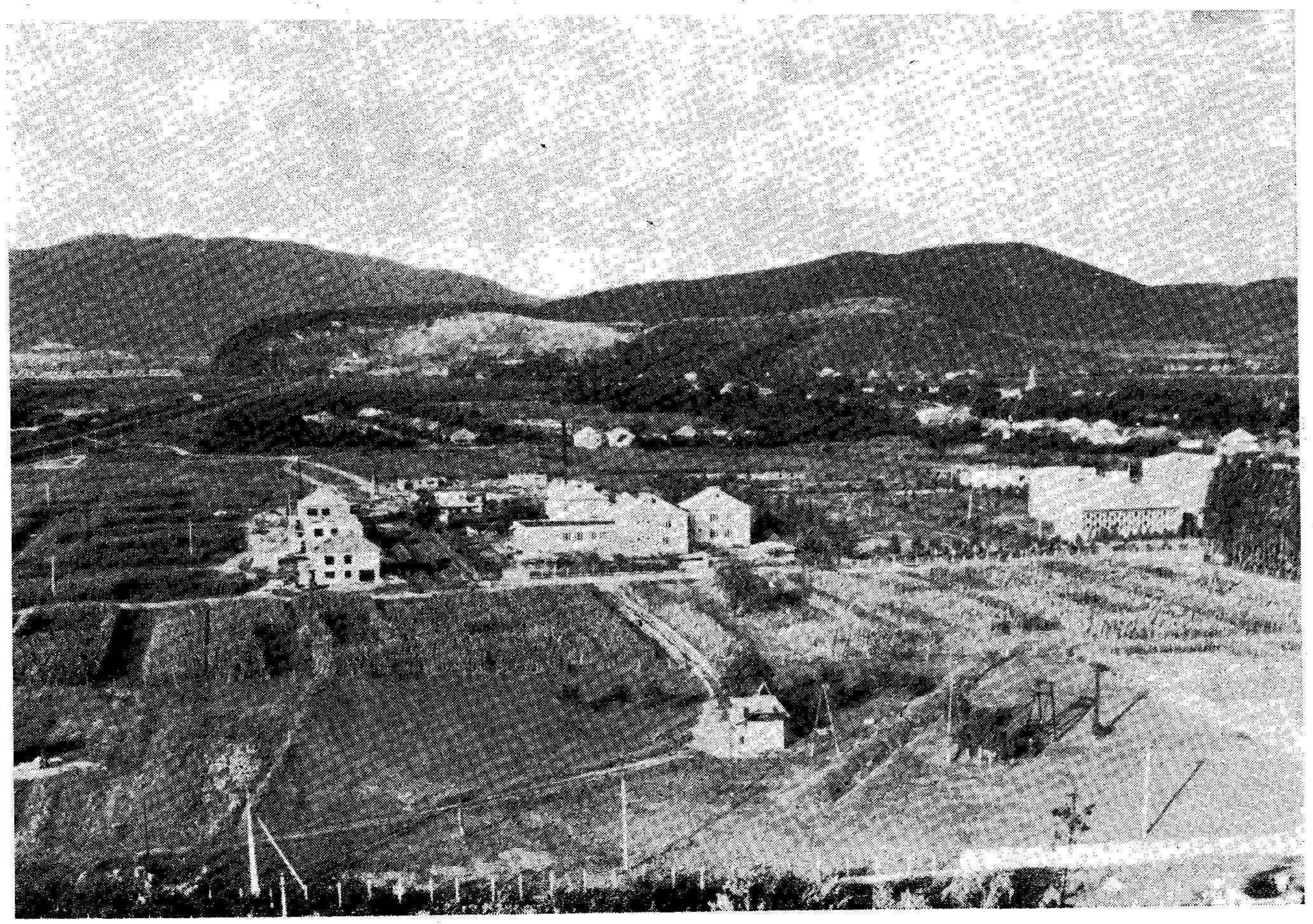

FIGURE 2. *A vista of the palaeolithic site in Korolevo from the Korolevo Castle.*

In these places appeared the Palaeolithic finds. The first finds were located on the central of the three peaks ("Beyvar"). They appeared on the surface of the sandy loams "suglinki" opened by scrapers at various depths in the wall of the quarry. It was evident at the first inspection of the site that we have to do with a multi-layered site. This was indicated by the various degree of the weathering of the stone industries, by their technical-typological characteristics, and by their varying levels in undisturbed Quaternary sediments.

In the course of the following research the above conclusions were endorsed. It appeared also that besides the "Beyvar" mountain, where the first finds were located, the site covers also the other mountain "Gostriy Verkh", and the 20 m high terrace adjoining the "Vinnyichki Mountain".

From the scientific viewpoint and to make the description easier the Korolevo site has been divided into two parts: Korolevo I ("Gostriy Verkh", "Beyvar") and Korolevo II (the 20 m high terrace beneath the "Vinnichki Mountain").

The method of research. On working out the method of researching the site it was necessary to take into account following facts: the sequence of the geological and archaeological stratigraphy of Transcarpathia has not been worked out, the site is situated in a quarry in operation, quarrying activities at various sections that cannot be stopped for a longer period, large extension of the site yielding the finds (more than 100 thousand sq. metres), the thickness of the deposits (up to 12 m), planigraphic, stratigraphic and morphological differentiation of the Palaeolithic complexes, natural destruction of the lithological and archaeological horizons, absence of animal remains, fireplaces and dwellings.

The method of opening one trench and its gradual extension to other parts was unacceptable in this case. It was imperative — under the menace of imminent destruction by quarrying — to determine the limits of the site within a reasonable time and to recognize a generalized section of it, to explain the stratigraphy of various sectors, to locate the palaeolithic complexes in plan and also in section, to put together a scientifically representative archaeological collection. To cope with these tasks in the fourteen field seasons on the "Gostriy Verkh" and "Beyvar" we made 15 probes, 34 trenches and opened 15 excavations of varying surface and depth, in line with the concrete tasks of the research. Three excavations and three trenches were realized on the 20 m terrace of the "Vinnyichki" Peak (Korolevo II). In total a surface of about 1 500 sq. metres has been excavated.

During the excavations 2×2 m squares were opened. In case that the soil was not disturbed and the complexes were not mixed, the finds were plotted in a chart. The finds were collected according to the lithological horizons, which in view of considerable vertical dispersion of the artifacts were additionally subdivided into 5 and 10 cm thick excavation levels.

Alongside with stratigraphic observation one of the main indicators for the temporal position of finds has been the weathering of the artifacts made of volcanic materials, of andesite and obsidian, the main raw materials used for the manufacture of tools. The state of preservation differs in products coming from various cultural horizons: varies the degree of patination, and also the so-called cellular leaching. It has been concluded that the cells (cavities) of leaching arising as a result of the disintegration of less resistant granularities included in the mass of andesite and obsidian, are the more frequent, larger and deeper, the older are the artifacts. More accurate stratigraphic and planigraphic observations alongside with the techno-typological features fives the possibility to attach even the material redeposited in past or collected in Korolevo as well as in a number of other Palaeolithic sites in Transcarpathia, to our material found in situ. We have to do thus with a new, prospective method of relative dating in the Palaeolithic, with the hydratation method.

In order to organize complex research in Korolevo we managed to attract a large number of specialists in natural sciences: geologists (O. M. Adamenko, M. F. Veklich, G. D. Gorodetskaya), palaeopedologists (N. A. Sirenk), geophysicists (G. A. Pospelova), palaeontologists (R. S. Adamenko), palynologists (G. M. Levkovskaya, G. A. Pashkevich), and specialists for thermolominiscency (V. N. Shelkoplyas) and radiocarbon dating (L. D. Sulerzhitskiy). Besides Korolevo the complex research was realized also at other archaeological and geological sites of Transcarpathia (Beregovo I, Nizhniy Koropets, Sosnoviy Gay, Onok). Thanks to the use of micromorphological, palaeopedological, palynological, thermoluminiscent, radiocarbon, lithologo-mineralogical, palaeomagnetic, palaeontological and archaeological methods it has been possible to divide the subareal Quaternary cover of Transcarpathia into a number of stratigraphic horizons, linked with the regional horizons of the Anthropogene of Eastern and Central Europe. Nine soils and pedocomplexes were found here, dating from Günz-Mindel to Holocene. In the Korolevo site proper, in the cover of deluvial deposits of up to 12 m seven palaeosoils appeared, corresponding to soils III—IX of the Transcarpathian regional section (Gladilin, 1982, 1985; Adamenko et al., 1977, 1979, 1981a, 1981b, 1984, in press; Sulerzhitskiy et al., 1984). Two of the upper fossil soils (I an II), have not been preserved here. In Transcarpathia they appear at the Upper Palaeolithic sites Beregovo I and at a site in Nizhniy Koropets, not containing any archaeological finds.

Stratigraphy. The thickness of the Quaternary cover in Korolevo varies in various sectors at places dropping to 1 metre or even less. Accordingly varies also the stratigraphic picture. Most complete are the sections obtained at "Gostriy Verkh", at trenches Nos. 14, 18, 26 and in excavations X and XII. On the peak "Beyvar" Mountain the deposits are thin and are represented by later geological layer.

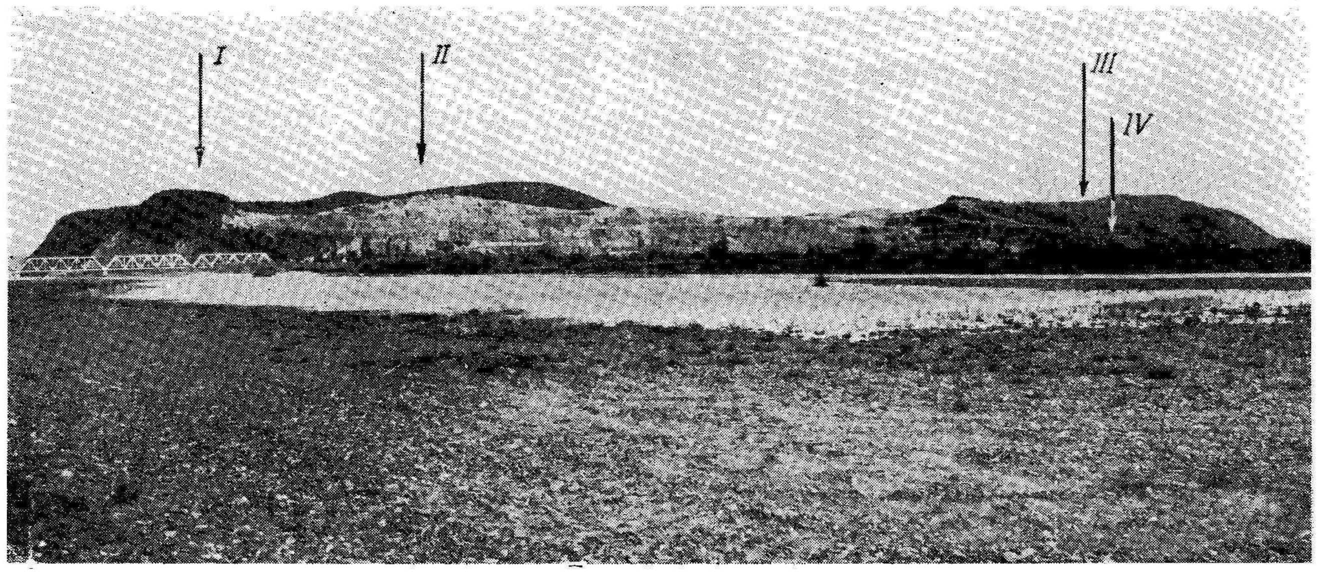

FIGURE 3. *A view of the palaeolithic site in Korolevo, from the Tisa River. I — "Gostriy Verkh", II — "Bey-var", III — "Vinnyichki", IV — Korolevo II.*

As a rule here appear only fossil soils III and IV of the regional stratigraphy. Earlier horizons (Vth and partially VIth fossil soil of the Transcarpathian section) have been preserved only in the fillings of the fossil ravines eroded in the mouldered crust of rocks. At Korolevo II, below the mountain "Vinnichki" three palaeosoils have been found: III, IV and V.

Lithology. Below follows the description of the sections in trenches Nos. 18 and 26 on "Gostriy Verkh" Mountain (*fig. 3*).

1. Recent brown forest soil that has arisen under deciduous forest. The thickness of the layer is up to 0.5 m.

2. Loess-like loam, light-yellow, reddish, coarse porous; thickness up to 0.5 m.

3. Loess-like loam, whitish with slight admixtures of manganese-iron concretions; their content is growing downwards, the thickness reaches up to 0.35 m.

4. Light-brown loam with light ochre-red hue, and with numerous bean-shaped concretions of iron and manganese hydroxides. The content of these admixtures is growing upwards; it is fragmented by vertical fissures (cavities after the plant roots filled with loam from the higher layer IIIrd fossil soil of the regional section of the Transcarpathian Anthropogene; it is up to 0.40 m thick.

5. Light-yellow loamy clay, porous; interrupted by fissures filled with gray-whitish loam; it is up to 0.15 m thick.

6. The same loam containing grained and flat iron-manganese concentrations; thickness is up to 0.40 m.

7. Brown loam with ochre-red hue and with numerous bean-shaped concentrations, of nut-like structure, aggregated; with vertical fissures filled with white loam and with loam of layer 5; the upper horizon of the IVth fossil soil of the anthropogenic section of Transcarpathia; it is up to 0.20 cm thick.

8. The same brown loam, but without significant iron-manganese concentrations (the iron content appears in the form of mould in the fissures; with vertical fissures filled with whitish loam and with loam from layer 5: lower horizon of the IVth fossil soil of Transcarpathia; its thickness is up to 1.40 m.

9. Light-coloured loam, porous with rare and small iron-manganese concentrations; thickness up to 0.46 m.

10. Light-coloured loam with light ochre-red hue and with frequent small and medium-sized bean-shaped and blotchy iron-manganese concentrations: top horizon of the Vth fossil soil of Transcarpathia's general stratigraphic section; thickness up to 0.30 m.

11. Yellow-brownish loam of ochre-red hue, grainy, porous, with fissures, with scattered small iron-manganese concentrations in the fissures, looking like mould — the fissures are filled with whitish loam: the second horizon of the Vth fossil soil; thickness up to 0.65 m.

12. Light-coloured loam, similar to loam of level 10, but with somewhat less frequent iron-manganese concretions: third horizon of the Vth fossil soil; thickness up to 0.65 m.

13. Yellow-reddish loam, similar to layer II, but of more pronounced ochre-red hue, with frequent fissures filled with whitish loam: it is the fourth lower horizon of the Vth fossil soil of the regional section of Transcarpathia; thickness up to 0.50 m.

14. Somewhat lighter and less ochre-coloured loam, the higher situated loam (Nr. 13), the fissures filled with whitish loam are less frequent; thickness up to 0.30 m.

15. Yellow-brownish loam with rare iron-manganese concentrations in the form of concretions and moulds; numerous fissures, filled with whitish loam; VIth fossil soil of the general Transcarpathian section; thickness up to 1.35 m.

16. Light-yellow loam with rare and small iron-manganese concentrations; thickness up to 0.35 m.

17. Brown loam with small and medium-sized iron-manganese concentrations, more frequent than in the higher layers (Nr. 16); fragmented by fissures, filled by loam of layer 16; upper horizon of the VIIth fossil soil; thickness of the layer up to 0.60 m.

18. Red-brown loam with ochre-red layer; in the upper half there are vertical fissures filled with whitish loam; in the lower half there are horizontal streaks of the same loam (gleyfication); it is the lower horizon of the VIIth fossil ridge soil; thickness up to 0.40 m.

19. Yellowish-light loam with thin fissures filled with whitish loam; mould-like traces of iron; thickness up to 0.10 m.

20. Loam similar to the above mentioned (Nr. 19), but with ochre-red hue with relatively frequent small iron-manganese concentrations; the upper horizon of the VIIIth fossil soil of the Transcarpathian Anthropogene; thickness up to 0.55 m.

21. Gray-brownish loam with ochre-red hue and with relatively frequent small or medium-sized iron-manganese concentrations; with fissures filled with whitish loam; the lower horizon of the VIIIth fossil soil; thickness up to 1.00 m.

22. Greyish loam with frequent small, medium-sized and large iron-manganese concentrations; the upper horizon of the IXth fossil soil; thickness up to 0.10 m.

23. Loam analogous to that of layer 21; lower horizon of the IXth fossil soil; thickness up to 0.35 m.

24. Ochre-red loam containing smaller fragments of dacites; deluvium of crust, weathering crust of rocks; thickness up to 0.10 m.

25. Multicoloured loam, spotty (spots of yellow, grey, whitish hues); in the upper part horizontal streaks of whitish loam, alluvium of the river terrace; thickness up to 0.35 m.

26. The same loam with small pebbles (up to 5 cm); alluvium; thickness up to 0.80 m.

27. The same loam with marked ochre-red hue and with big pebbles; alluvium; thickness up to 0.30 m.

28. The weathering crust of the dacite.

Palynology. Spore and pollen analysis of the samples of the Korolevo sediments was realized by G. A. Pashkevich (1984) (layers 2—14), and by G. M. Levkovskaya (1988) (layers 15—27).

Layers 2—3. The spore and pollen analyses have proved the pollens of coniferous and deciduous woods. Wide-spread were the pine woods combined with birches, with not too significant presence of oak, hornbeam and hazel-nut shrubs in the undergrowth. The considerable amount of grass pollen shows that there existed extensive formations of mixed meadows. The climate was cooler and drier than today.

Layer 4. At the time of the formation of this layer (fossil soil Nr. III) there were spruce woods in the mountains and oak-pine woods in the foothills and in the lowlands. Charakteristic is the absence of fir trees, indicating that the climate had become drier. From the deciduous trees, besides two species of oak there were also ash-, elm- and lime-trees. The grassy cover of meadow character was well developed. The climate was milder than now, but the annual mean temperatures were lower than was the case in the period of the formation of the earlier fossil soil IV, and also lower than now.

Layer 7. In that time (upper horizon of the IVth fossil soil) the river valleys were dominated by coniferous forests, with fir prevailing, but there were also cedar pines and larches. The drier talus slopes were covered by common pine and cedar pine. The climate was steady, without violent changes of temperatures and humidity, with heavy precipitation (not less than 600 mm per annum).

Layer 8. The spore and pollen spectra from this layer (lower horizon of the IVth fossil soil) documents that the landscape of the epoch was dominated by deciduous forests — by oaks, hornbeam with oak and beech trees. There are few coniferous tree forests represented by pine and spruce. There was a well-developed grass cover in the forests, and the latter were combined with meadows. The climate was warmer and more humid than now, with higher winter temperatures. This is typical of the Riss-Würm Interglacial, when the weather conditions were well balanced from France to eastern Ukraine.

Layer 10. According to the results of the spore and pollen analyses of the landscapes of corresponding period prevailed coniferous woods. There were also areas of meadows with a rich variety of plants and also with steppe elements.

Layer 13. In the time of forming this layer in the river valleys prevailed coniferous forests (three types of pine — common pine, cedar pine and European pine, than spruce, larch and fir). The higher parts of lowlands and the foothills of the mountains were covered with common pines, perhaps also with cedar pines. The mountains were covered by the Carpathian taiga (larch, spruce, fir, mixed with deciduous trees — oak, beech and alder-tree). The climate was mild with considerable amount of precipitations.

Layer 15. In the section of the lower part of trench Nr. 18 from the VIth fossil soil to the formation of the alluvium (layers 15—17) a number of pollen-zones appeared, indicating that the favourable climatic conditions — thermomers, alternate with cold condition — cryomers. In layer 15 (the VIth fossil soil) from below upwards thermomer X, cryomer XI and thermomer XI have been determined. It means that to the VIth fossil soil correspond two optima, separated by a short period of cooling down, and by the extension of the area covered with spruce (cryomer XI). Both these optima correspond to a single warm interglacial, the climate of which was more humid than the climates of the earlier thermomers. During the interglacial the territory was mostly covered with forests. In the samples appeared pollens of xerophilous trees (cork-elm, hornbeam) and grass species forming xerophilous associations. One of the characteristic features is the continuous presence of *Pterocarya* pollen. The climatic situation of the earlier and later of the two optima was identical. The earlier was characterized by a very short domination of elm, with a relatively rare presence of *Pterocarya*, present with a not developed pollen of deciduous trees. Only in its second-half appeared the fir and beech. The later optimum differs from all optima, as documented by the Korolevo section, with the largest extension of *Pterocarya*.

Cryomer XI corresponds to the level inside the VI[th] soil. In the spectra we find a considerable amount of grass and shrub pollens (sedges, chicory). Among the tree pollens prevails usually spruce pollen, and among deciduous trees elm. Corresponding deposits yielded also *Pterocarya* and fir pollen. Perhaps they got there from the underlying deposits, as on the level of the studied samples in the excavation there were found traces of solifluction.

Layers 16—17. Here appeared cryomer IX corresponding to the time of the formation of the upper-half of the VII[th] soil, and also the deposits dividing soils VII and VI. The degree of afforestation was small, especially in the second-half of the stage. The mean pollen content of the tree species in the first-half of this stage was 40 %, in the second — 18 %. The forests were dominated first by treelike birch (*Betula verrucosa*, B. *pubescens*, B. *torbuosa*), appeared also *Betula humilis*, and later also alder-tree (*Alnus viridis*). A large deal of the landscape was devoid of forests, covered with grass and with groups of brushes — with goose-foot, aster-like, chicory-like, sedges, bent grass, cereals and with a variety of grasses. Pollen of various types of gost's beard (*Tragopogon* sp.). One of the goat's beards (*Tragopogon dubius* Scorp.) is a weed. It grows also in dry meadows and steppes. Among the pollens prevail various poorly developed tricorporate pollen. There is evidence of salt-ridden lands: many pollen grains are shining and under microscope we can see that they are covered with a colloid film. In some of the samples pollen and spores are rare — evidently there were unfavourable conditions for the production of pollen and spores of plants. At the beginning of the above-mentioned cryomer there was a periglacial forest-steppe with birch trees, later the vegetation showed features similar to that of the southern part of the Carpathian sub-Alpine zone, with extensive sections covered with alder-tree woods (*Alnus viridis*). Nevertheless the given area in the most adverse climatic stages served as a refuge for the survival of the deciduous tree species, which appeared in limited quantity due to the unfavorable climate, and as a consequence of adverse conditions they produced poorly developed and deformed pollen and survived only in several isolated places.

Layer 18. Thermomer VIII is the lower part of the VII[th] soil. The vegetation of that period had some similarities with the vegetation of thermomer IV (see below): in the woods dominated the elm, in the first-half of the stage there were also numerous hornbeams. Nevertheless the edaphoclimatic conditions in this period were not good for the maturation of the pollen of deciduous trees. The climate of the period we are studying was cooler and drier than the climate of thermomer IV. In the drier xerophilous phases of thermomer IV are represented by the extension of hornbeam, cork-elm or oak, with considerable afforestation of the region, but in the studied thermomer VIII the phases of the cork-elm, oak and hornbeam are not strongly expressed. In this time larger areas were occupied by xerophilous woodless associations formed by goose-foot, aster-like and chicory-like plants and by sedges among the latter also fritillary (*Fritillaria* L.). Certain fritillary species grew in the flood-plain meadows, especially in damp and saltish ones. The saltiness of the soil can be documented also by the fact that many pollen grains are with colloid film. The afforestation of the region in this epoch was not excessive — the mean pollen content of tree species in thermomer VIII was 40 %. This thermomer was characterized also by smaller frequency of walnut (1 — 3 % at its beginning and at its end, and only during its optimum phase amounted to 30 %). As regards exotic trees, pollen of *Zelcova* sp. and *Pterocarya* sp. and also of an exotic pine (*Pinus* s/g *Haploxylon*) were found.

Layer 19. Cryomer VII has been recognized. It is the first cool period in the zone of reverse palaeomagnetic Brunhes epoch. It corresponds to the cryogenic failures (solifluxion of the surface of the VIII[th] soil, ice-wedge like deformation). Accumulations formed in the first-half of this stage contain only solitary pollen grains. The second-half of the stage was characterized by the domination of woodless plant associations formed by goose-foot, sedge, aster-like plants, cereals and various grasses. Among the grass species appeared toffee, umbelliferous plants, bean-like and closer non-determined grasses and also *Polemonium*. In one sample 6 poorly developed pollen grains of this plant were found alongside with one well developed grain reminding of blue Jacob's ladder (*Polemonium acubiflorum*), growing at present in the mossy tundra, in mossy moorlands, on the banks of rivers and lakes. Tree pollen is represented here by deformed pollen of alder and elm (they prevail), but also by hornbeam, walnut and pine. The deformation of the pollen documents that the conditions for its growth were not very favourable. A considerable amount of mushroom spores found here demonstrate the very humid character of the soil (the appearance of permafrost created waterproof layers and had resulted in strong humidity of soils.

Layers 20—21. These layers correspond to thermomer VI. This phase corresponded to a short improvement of the climatic conditions (interphase), and the territory was not heavily afforested (the content of tree pollens is 30—45 %), with deciduous trees mostly with birches and alder-trees. There were also spruce, larch and dwarf-birch. It seems that the deciduous forests existed only in the best protected locations. They were represented by oak, elm, and partially also by walnut. This was the periglacial wood-steppe.

Layer 22. Here we defined cryomer V corresponding to the top of the IX[th] soil, and to the lower

strata of the VIII[th] soil. It agrees with the Brunhes Matuyama Palaeomagnetic limit. In the Korolevo region in this period large areas were covered with boreal and birch/pine forests, and with not-too-significant presence of deciduous trees — of alder, hornbeam, oak and elm. The climate was moderately cold.

Layer 23. The palynological data in this layer point to thermomer IV. In the spectres prevail pollens of trees in the following order: 1. elm, 2. walnut and elm, 3. poorly developed pollen of oak and elm. This optimum differs from the others with considerable extension of cork-elm and hornbeam — both xerophilous. In the time of the above thermomer, woods covered considerable areas. The extent of afforestation decreased towards its end (in the period of intense forming of the humic horizon of the IX[th] soil). There prevailed various types of deciduous trees, dispersed according to the relief and to the soil cover.

Layer 25. In this layer appeared the pollen complexes of cryomer III. In that period prevailed in the forests birch and pine but in contrast to cryomer I (see below), gradually appears also spruce. In the most favourable locations have been preserved also deciduous tree species, such as oak, walnut, elm and hornbeam. The climate of this cryomer was moderately cool.

Layer 26. In the layer thermomer II has been identified. It was of short duration, but it had two phases. In the group of deciduous trees in the optimum dominates the often poorly developed elm pollen. We encounter also hornbeam, in small quantity also deformed pollen of walnut and beech. In this period possibly appears in small quantities also *Pterocarya* sp., as this transferred pollen was found also in the deposits of cool phase III, spontaneously following thermomer II. The initial phase of this minimum differs from the initial phases of all the following optima with considerable extension of spruce.

The palynological facts suggest that these sediments were brought by water (there appeared remains of *Azolla*, diatomaceous water plants of the *Pennales* order, and *Pediastrum*). During the period of the formation of layer 26 the climat was evidently cool, therefore the pollen of deciduous trees are absent.

Layer 27. In this layer pollen complexes corresponding to cryomer I have been separated. At the beginning of this cryomer prevailed the pollen of pine and birch. In the higher horizons the accumulations of pollen and spores appear rarely.

Fauna. No fanual remains have been discovered in Korolevo. In most cases they do not appear in the Transcarpathian Palaeolithic open air sites. Of great importance are therefore the bones of rodents determined by R. S. Adamenko in the alluvial accumulations of the Kopanski Terrace on which the Korolevo site is situated. The species found here are related with the Taman faunal complex (*Ochotona* sp., *Citellus* sp., *Villányia* sp., *Mimomys* ex gr. ***coelodus***. *Mimomys* sp. *Microtinae* gen. indet., *Allophaiomys* sp., *Lagurini* gen. indet.) of the end of Upper Pliocene till Günz glacial.

Thermoluminiscent data. The thermoluminiscent analysis of the samples was realized by V. N. Shelkoplyas, with the following results:

Layer 2 — 35 ± 6 thousand years
Layer 5 — 60 ± 8 thousand years
Layer 9 — 150 ± 20 thousand years
Layer 12 — 220 ± 35 thousand years
Layer 16 — 360 ± 50 thousand years
Layer 19 — 650 ± 90 thousand years
Layer 25 — 850 ± 100 thousand years

Palaeomagnetic data. The palaeomagnetic research in Korolevo was realized by G. A. Pospelova. From the palaeomagnetic viewpoint the section of the Korolevo site has been researched in detail in three excavations whence the oriented samples have been taken, with 1 + 1.5 cm distance between the sample blocks. The samples have been taken from the most homogeneous parts of the sediment, without vertical fissures filled with material washed in from the higher layer, without deformations and disturbances. The studied collection consist of more than one thousand samples.

For each excavation partial palaeomagnetic sections have been worked out, with correlations between them, and also with other Transcarpathian

TABLE 1. *Technical Indices of the Lower Palaeolithic Assemblages of Korolevo*

Indices	Assemblages						
	VIII	VII	VI	Va	V	IVa	III
I L	0	1.8	2.5	6.5	7.1	14	13
I of protoprismatic technique	24	25	20	32	30	20	21
I lam	5	3	4.7	6.8	7.8	16	9
I Fs	0	0	0.3	2.7	2.8	2	8
I F	0	8.2	10.7	26.5	24	23	29
Coefficient of the massivity of flakes	33	32.3	31.7	25.3	25	—	—

excavations (Beregovo I, Nizhniy Koropets, Onok, Sosnoviy Gay).

In consequence of the realized palaeomagnetic research it has been concluded that in the sections of two excavations of open-air sediments of Korolevo according to the existing and primary residual magnetism can be recognized two zones: a mighty zone of prevailingly reverse polarity, and a small zone of inverse polarity. The palaeomagnetic zones without doubt can be compared with the Brunhes zones, and with the top part of the Matuyama zone. The limit of the Matuyama-Brunhes zone date to 730 thousand years B. P. passing between the VIIIth and IXth fossil soils. The zone of direct Brunhes polarity in the sections of three excavations appeared not to be homogeneous as regards the direction of the magnetization. In the summary in the palaeomagnetic section of Korolevo based on three partial sections seven palaeomagnetic anomalies (events) (PMA) have been identified:

I. Bottom of layer 3: Kargopol's PMA, more than 44 thousand years
II. Bottom of layer 8: Blake's PMA, 106—114 thousand years
III. Bottom of layer 9: Biva I PMA — 180 thousand years
IV. Layer 14: Biva II, PMA — 210 thousand years
V. Bottom of layer 16: Biva III PMA — 350 thousand years
VI. Layer 19: Elunino I PMA — 500—600 thousand years
VII. Top of layer 20: Elunino II PMA — 620 thousand years.

Radiocarbon data: For the top parts of the Korolevo section there are two carbon data obtained by L. D. Sulerzhitskiy in the Geological Institute of the Academy of Sciences of the U.S.S.R. from the charcoal: for the loam of layer 5 on "Gostriy Verkh" — GIN-2772: 25 700 ± 400, and for the same loam of layer 6 in Korolevo II GIN-2774 38 500 ± 1 000 years.

Dating. The age of the formation of the fossil soils and of alluvial facies is of basic importance for dating the Korolevo sections. For a number of reasons of top importance is the dating of the topmost, IIIrd regional soil. Here we can mention several working hypotheses:

1. this soil corresponds to Paudorf;
2. the given soil is related to Hengelo—Podhradem interstadial;
3. the soil should compare with the accumulations of the Popperinge—Moershoofd interstadial;
4. the Korolevo top paleosoil is Brörup of polygenetic (Brörup + Odderade + Moershoofd) type.

It would be useless to say that the studied fossil soil is of Paudorf age. All the available data are against it, not to mention that it does not agree with the chronological point of the radiocarbon dating. Naturally the C^{14} dating of 25 700 ± years for the loam beneath the soil cannot fix the beginning of the Paudorf Interstadial. There is no Paudorf soil in Korolevo; two top Late Pleistocene palaeosoils of the regional section have not been preserved here. They appear in other Quaternary sections of Transcarpathia, namely in the Upper Palaeolithic site Beregovo I. It can be demonstrated that in Beregovo I above the Paudorf soil, well dated with palaeopedological and palaeomagnetic methods, in the lower parts of the loam covering it there is a cultural horizon containing developed Aurignacian industry. If we are to suggest that this soil is synchronous with the uppermost soil in Korolevo, then we should also admit that in Early Würm III coexisted in Transcarpathia Mousterian and Upper Palaeolithic industries, represented by the 1st Mousterian horizon in Korolevo, and by the developed Upper Palaeolithic in Beregovo I situated in the loams covering these soils. If we take into account the present knowledge of the development of Upper Palaeolithic industries, such a conclusion would appear as an absolute nonsense.

Let me suggest now that the upper fossil soil of Korolevo is related to the Hengelo—Podhradem Interstadial. This hypothesis is contradicted by all the datings, with the exception of a radiocarbon dating — 38 500 ± 100 years (GIN 2774) for the loam beneath the soil and containing Upper Palaeolithic remains in the Korolevo II site. The upper palaeosoil in Korolevo is well visible in the section and it is up to 0.40 cm thick. The Hengelo—Podhradem soils, on the other hand, are difficult to distinguish, as a rule, or they are not visible in the loess sections. In the numerous Quaternary sections of Ukraine, studied and described by M. F. Veklich (1968) the deposits of the Hengelo—Podhradem interstadial in the best case are represented by thin embryonal humic layers in the lower strata of the so-called Bug Forest. In Palaeolithic sites closer to Transcarpathia, such as Korman IV and Molodova V (Ivanova, 1977, 1987) the soils of the interstadial were not thick and have been washed away by solifluction, not observed in Korolevo. According to the results of the spore- and pollen analysis in the period of the accumulation of the Korolevo Upper Palaeolithic the foothills and the lowlands were covered with deciduous forests. We receive a different picture from the results of the Hengelo—Podhradem palynological research. In the sites Korman IV and Molodova V in the Dniester River Valley, according to G. A. Pashkevich (1987) the soil of the given period belongs to the category of steppe soils. The spore and pollen analysis points to temperate climate and to the prevalence of pine woods. In the Upper Palaeolithic sites in the Kostienki—Borshevo region of the Don River, belonging to the Hengelo—Podhradem Interstadial the lower humous layer has been washed away by the solifluction. According to the spore-pollen data the layer was sedimented when the forest-steppe conditions were replaced by taiga conditions (Levkovskaya, 1977).

The absolute dating of the upper fossil soil in Korolevo is based primarily on palaeomagnetic and thermoluminiscent data. For the underlying loam there are two TL-dates: 60 ± 8 thousand years. For the overlaying loam containing in its lower part Mousterian industries there are also two dates:

TL — 35 ± 6 thousand years and palaeomagnetic 44 thousand years (Kargopolovo event). This dating does not agree with the currently accepted ideas of the age of interstadial Hengelo—Podhradem, that is 38—36 thousand years ago.

The arguments analogous to those used against the classification of the upper fossil soil in Korolevo to Hengelo—Podhradem interstadial hold fully also with regards to the Popperinge—Moershoofd interstadial. In the loess sections of the deposits of this age they are usually absent, or they appear (in the Molodova) only with thin soot-like soil streaks (Ivanova, 1987). The spore and pollen analysis has shown here a wide extensions of forests, with pines greatly prevailing, and with very few (1—2 %) deciduous trees.

As we can see from the comparison of the three hypotheses on the age of the upper palaeosoil in Korolevo, according to the existing data none of them is acceptable. Remains the fourth and last supposition: the given soil is related to the Brörup Interstadial. This supposition is based practically on the sum of information on the age of the soil, obtained through various methods. In contradiction with this conclusion are two of the above-mentioned data for Korolevo I and Korolevo II. Evidently we cannot reassess the significance of radiocarbon data in opposition to other facts. There is no need to mention the numerous examples when such dates gave striking differences. This happened partially in Kostienki on dating the lower humus layer, this happened also in Sungir and in many other cases. It can be demonstrated that the errors in these cases always tended, not to make the sites earlier, but to make them later. We have the impression that the radiocarbon method is somehow "stumbling" on approaching the limit of 35—40 thousand years B.P., and behind this limit it limps on both legs. It can be documented by two C^{14} data for the top of Brörup fossil soil in Molodova V and I sites of more than 40 300 and 45 600 years respectively, while the generally accepted age of the Brörup Interstadial, together with Odderade is 64—65 thousand years. The "sooty" streak formed in the Dniester River Valley by a single fire in the Molodova sites is dated to more than 35 000 years, in the Korman IV site 44 000 $^{+\,2\,050}_{-\,1\,600}$ years. How could we not to agree here with N. D. Praslov (1984) stating "that the radiocarbon method can be used only in limited chronological band, up to 67 thousand years, and the data above 35—40 thousand years should be treated with great caution, as they are close the margin".

There exists, however, also other explanation to the rejuvenation of radiocarbon data in Korolevo. Evidently it is due to their contamination with much younger charcoal (in Korolevo I Hallstattian urns containing burials are buried into Ia cultural horizon containing Upper Palaeolithic finds) not to mention the addition of remains of decayed roots of recent plants, which are quite difficult to distinguish visually from the small charcoals.

Thus we have sufficient clues to relate the third fossil soil in Korolevo to the Brörup Interstadial. We cannot exclude, however, that the upper fossil soil is polygenetic and has been formed by sediments of Brörup proper, and also by the following ones, corresponding to the Odderade and Moershoofd interstadials in northern Europe. It is evident that both possibilities must be taken into account on determining the chronological framework of Interstadial Würm I/II of the central European scheme, which, since some time — and as appears without proper ground — is being synchronizied exclusively with the Hengelo—Podhradem deposists. In case of both Upper Palaeolithic industries in Korolevo, situated below the top fossil soil the dating coincides with the pre-Brörup period of Würm I.

The paleosol IV according to all data (morphological, palaeopedological, thermoluminiscent) can be related with confidence to Riss—Würm. Perhaps its ironized upper horizon corresponds to Amersfoort.

In the same way the palaeosol V should be synchronized with Riss 2/3 and Riss 1/2 interstadials.

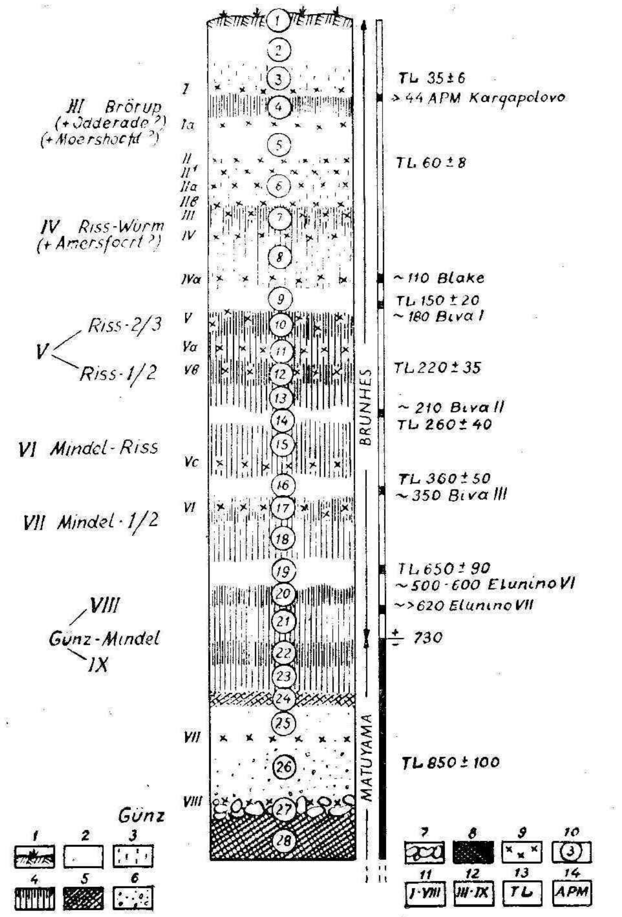

FIGURE 4. *Korolevo. Stratigraphic section.* 1 — *turf layer,* 2 — *loam,* 3 — *slightly ferruginous clay,* 4 — *fossil soils,* 5 — *deluvial crust of weathered bedrocks,* 6 — *alluvia of the nominal facies,* 7 — *alluvia of the river-bed facies,* 8 — *the crust of weathered dacites,* 9 — *stone tools,* 10 — *the numbering of the lithological layers,* 11 — *cultural horizons,* 12 — *fossil soils,* 13 — *thermoluminiscent data,* 14 — *palaeomagnetic anomalies.*

The formation of fossil soil VI is determined reliably. The Mindel—Riss age of this soil is reliably documented with the palaeopedological, palaeomagnetic and thermoluminiscent data and also by the palynological research by G. M. Levkovskaya, determining the pollen and spore content and pointing to corresponding analogies. In agreement with G. M. Levkovskaya (Adamenko et al. 1988) in the warm optima appearing in the interval from the Brunhes—Matuyama dividing line to the Riss—Würm interglacial the warmest climate has been fixed by numerous palaeobotanical data. They were registered in Western and in Eastern Europe in Riss—Würm and Mindel—Riss interglacials (Holstein in Central Europe, Likhvinsk, Alexandriysk, Butenaysk interglacials in various regions of the European part of the U.S.S.R.). The optima corresponding to soil VI resemble the optimum of the Holstein type. In a score of diagrams representing North European sections the optimum of Holstein type is determined in its final phase by the presence of fir and occasionally of a solitary *Pterocarya*. In the conditions of the warmer and temperate Carpathian region the corresponding phase has more *Pterocarya* and fir, and less hornbeam. At present in a number of regions appeared two optima of the Holstein type. In the territory of the Soviet Union similar data have been obtained in the Krukenichi section situated in the Lvov region. Soil VI of the Korolevo section corresponds to the full section of the deposits of the Likhvinsk Interglacial with two optima. Of course there are some differences in the palynological characteristics of the optima of the Mindel—Riss Interglacials in Korolevo on the one side, and between the Krukenichi section, on the other. In the latter the earlier of the two optima was warmer and more temperate. In the Korolevo section *Pterocarya*, a thermophile species requiring also much humidity, was most extended in the later optimum. In Western Europe some scholars point out also the existence of two similar "Holstein"-type optima. The earlier of them — "Dömnitz" — is regarded as a Mindel—Riss interstadial, preceding "Holstein" interglacial. According to other data the early optimum with its zone of fir and hornbeam ("Voigtstedt") corresponds to the end of Cromer. It differs from the much later similar "Voigtstedt" optimum through its glacigenum sediments of the initial phase of the Elster—Glacial (Adamenko et al. 1988).

Paleosols VII, VIII, IX according to palaeomagnetic, thermoluminiscent and palynological dating are put to Intermindel (VII) and Günz—Mindel (VIII, IX) respectively.

The alluvium in the basal part of the section, according to palaeomagnetic, thermoluminiscent and palaeontological data is put to Günz—Mindel (the flood-plain facies layers 25—26) and to Günz (the fluvial facies layer 27). (In the former literature, without the knowledge of the results of palynological and thermoluminiscent data, layers 12—23 and the cultural horizons included in them are regarded being much later.)

Archaeological data. On the basis of stratigraphic, planigraphic and morphological considerations 16 various stone tool complexes (cultural horizons) have been determined in the Korolevo I site: they include seven Acheulian (VIII, VII, VI, Vc, Vb, Va, V) seven Mousterian (IVa, IV, III, IIb, IIa, II, I), and two horizons coming from the initial phases of the Upper Palaeolithic (II[1], Ia); the stratigraphic situation of the complexes and their dating are indicated in *Fig. 3.*

According to the fulness of the cultural and chronological succession of the Palaeolithic, clear-cut geological situation, abundance and well-defined character of the archaeological materials, presence of assemblages forming the transition between Acheulian and Mousterian and from Mousterian to Upper Palaeolithic, Korolevo site has no analogies, not only in the Soviet Union; it is unique in wider regional context. The stratigraphic character of the site, the large number of cultural horizons of the Acheulian, Mousterian and Upper Palaeolithic periods are concentrated in a single place, the massive character of the stone industries found here (comprising a total of more than 70 000 artifacts), and finally its situation in the geographical centre of Europe, at the dividing line of two vast Palaeolithic regions — of the Central European and East European, all these facts make the Korolevo site one of the most important sites for studying the Palaeolithic in the south-west of the U.S.S.R. and of the neighbouring countries of Central Europe. The discovery of the site has offered us a unique opportunity to study-on the background of numerous changes of the natural environment in Eopleistocene and in Pleistocene — the evolution of stone working technique in a culturally unique Early Palaeolithic settlement during a long section of time, ranging from Acheulian to Mousterian and from Mousterian to Upper Palaeolithic.

The overlapping of Mousterian and of Upper Palaeolithic industries — the feature dealt with in detail in the contributions of Soviet authors in this issue will without doubt offer material for consideration.

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Dr. V. N. Gladilin
Archaeological museum
of the Academy of Science
of the Ukrainian SSR
Lenin Str. 15
252030 Kiev
USSR