Stratigraphy, palaeoenvironment and chronostratigraphic background of the Mira succession (Zaporozhiye, Central Ukraine), midway between Carpathians and Don

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Abstract: Located along the Dnieper, south of Dniepropetrovsk, the Mira site shows a thick succession of fluviatile sands capped by loess-like deposits. It included two cultural layers dated between 27.8 and 26.6 ka BP, preserved in a 55 cm thick fine alluvial deposit interbedded in the sands. Data on palaeopedology and palynology point to rather cool and dry conditions during a final phase of the Middle Pleniglacial, with meadow vegetation along the river banks and steppe vegetation on plateau. The upper cultural layer with abundant faunal remains and lithics included an archaic industry combining both Middle and Upper Palaeolithic features, and contained a remain of anatomically modern human. The lower cultural layer included a more advanced industry of Upper Palaeolithic appearance. With regard to its geographical position between Kostienki on the Don and the Carpathians, the Mira site provides new insight on the diversity of the Early Upper Palaeolithic at the end of the Middle Pleniglacial in the Russian Plain.

1 INTRODUCTION

The Palaeolithic open-air site of Mira is located in Central Ukraine on the right bank of the river Dnieper nearby Kanevskoye village about 30 km South of Dniepopetrovsk (47°40′ of N latitude and 34°50′ of E longitude). The site is connected to an alluvial terrace at the altitude of ca. 18–20 m above river level and 40 m a.s.l. The body of the terrace is cut by small modern ravine, oriented SE-NW and opened toward the Dnieper Valley (**figure 1**). First Palaeolithic finds were recovered here by engineer I.B. Pisaryev in 1995 due to slope erosion of the ravine. A trench installed at the site in 1997 revealed the stratified character of the Palaeolithic remains related to two cultural layers, which occurred at the depth of ca. 10 m below the surface and were preserved in a dark grey sandy loam belonging to the Upper Pleistocene terrace (Stepanchuk *et al.* 1998; Cohen & Stepanchuk 2000–2001). Large-scale excavations were conducted at the site in 2000, uncovering about 60 squares metres of culture-bearing sediments (Stepanchuk & Cohen 2001); additional stratigraphical survey was conducted at the site in June 2001.

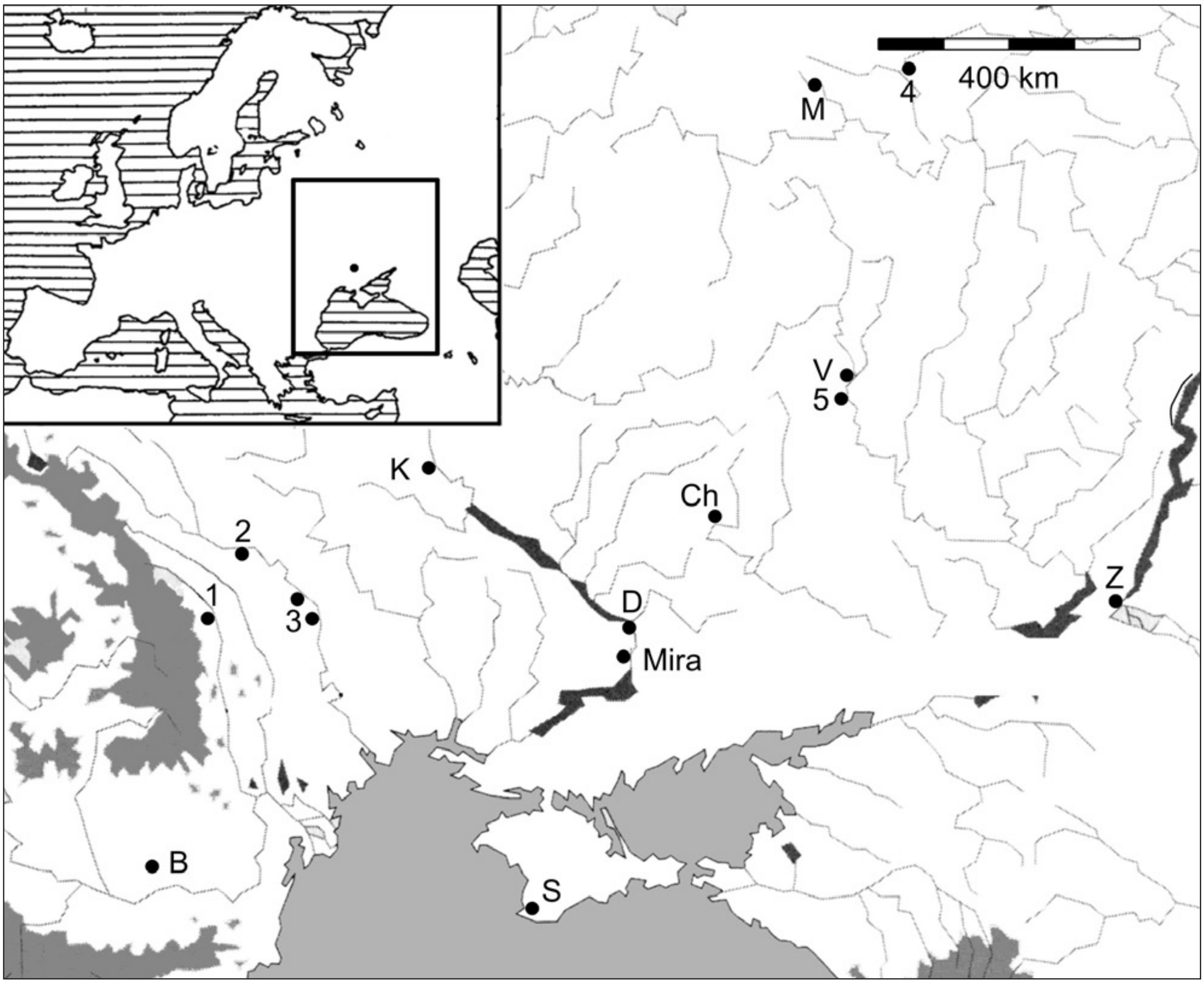


FIGURE 1 (Location map) – B. Bucharest; Ch. Charkov; D. Dniepropetrovsk; K. Kiev; M. Moscow; S. Sebastopol; V. Voronesh; Z. Zarizyn. Archaeological sites: 1. Mitoc-Malu Galben (Romania); 2. Molodova V (Western Ukraine); 3. Cosautsi and Climautsi (Republic of Moldova); 4. Sungir; 5. Kostienki (Russia).

2 STRATIGRAPHIC SUCCESSION (P.H. & N.G.)

The stratigraphical record of the Mira section encompasses almost 12 m of sedimentary succession exposed along the slope of the ravine opening to the Dnieper. The 50 cm thick dark grey sandy loam containing the two cultural layers could be followed laterally over several tens of meters; it occurred horizontally in between two sandy bodies of Dnieper alluvia which are passing upward to sub-aerial deposits capped by the Holocene pedocomplex (**figure 2**). From top to bottom, following succession was described at the excavation site in June 2001.

2.1 Subunit IA (layers 1 to 7: 0.00 to 2.00 m)

- L 1 (0.00 to 0.12 m) - Dark grey sandy loam with grass roots (Ao horizon);
- L 2 (0.12 to 0.37 m) - Light grey loose silty sand;
- L 3 (0.37 to 0.54 m) - Dark grey slightly compacted silty sand: with weak granular structure and earth-worm tracks (A1 horizon); gradual lower limit;
- L 4 (0.54 to 1.05 m) - Light grey slightly compacted silty sand, with krotovinas and worm routes; distinct lower limit;
- L 5 (1.05 to 1.50 m) - Dark grey slightly compacted sandy loam with granular structure and abundant krotovinas and worm galleries (A1 horizon); very gradual lower limit;
- L 6 (1.50 to 1.73 m) - Grey silty sand with mole and worm routes; pocket-like lower limit;
- L 7 (1.73 to 2.00 m) - Pale yellowish grey slightly compacted silty sand with many krotovinas and worm routes in the upper part. The lower limit is sharp, but the silty sand penetrates in the underlying deposit along thin fissures or in small pocket-like structures.

2.2 Subunit IB (layers 8 to 11: 2.00 to 4.50 m)

- L 8 (2.00 to 3.05 m) - Pale brown sandy loam with undulated compacted brown clayey bands and prismatic structure (banded Bt horizon); gradual lower limit.
- L 9 (3.05 to 3.80 m) - Compact pale brown sandy loam with fine banding and prismatic structure (transition from Bt to C horizon); fairly distinct lower limit.
- L 10 (3.80 to 4.10 m) - Pale yellow loess-like sandy loam; distinct lower limit.
- L 11 (4.10 to 4.50 m) - Bedded pale yellow sand, filling a gully cutting through layer 12.

2.3 Subunit IIA (layers 12 to 16: 4.10 to 6.90 m)

- L 12 (4.10 to 4.45 m) - Greyish brown silty sand occurring as an initial humic horizon.
- L 13 (4.45 to 5.00 m) - Light grey brown sandy loam; the thickness increases in accordance with the slope of the present gully opening to the Dnieper.
- L 14 (5.00 to 5.40 m) - Light grey sand with fine cross-bedding.
- L 15 (5.40 to 6.20 m) - Pale brown silty sand, mottled with Fe-Mn hydroxides and gley patches. The upper part of the layer is darker, the lower part is more gleyed. Downslope, layer 15 is horizontally bedded, with thin greyish brown bands and worm burrows.

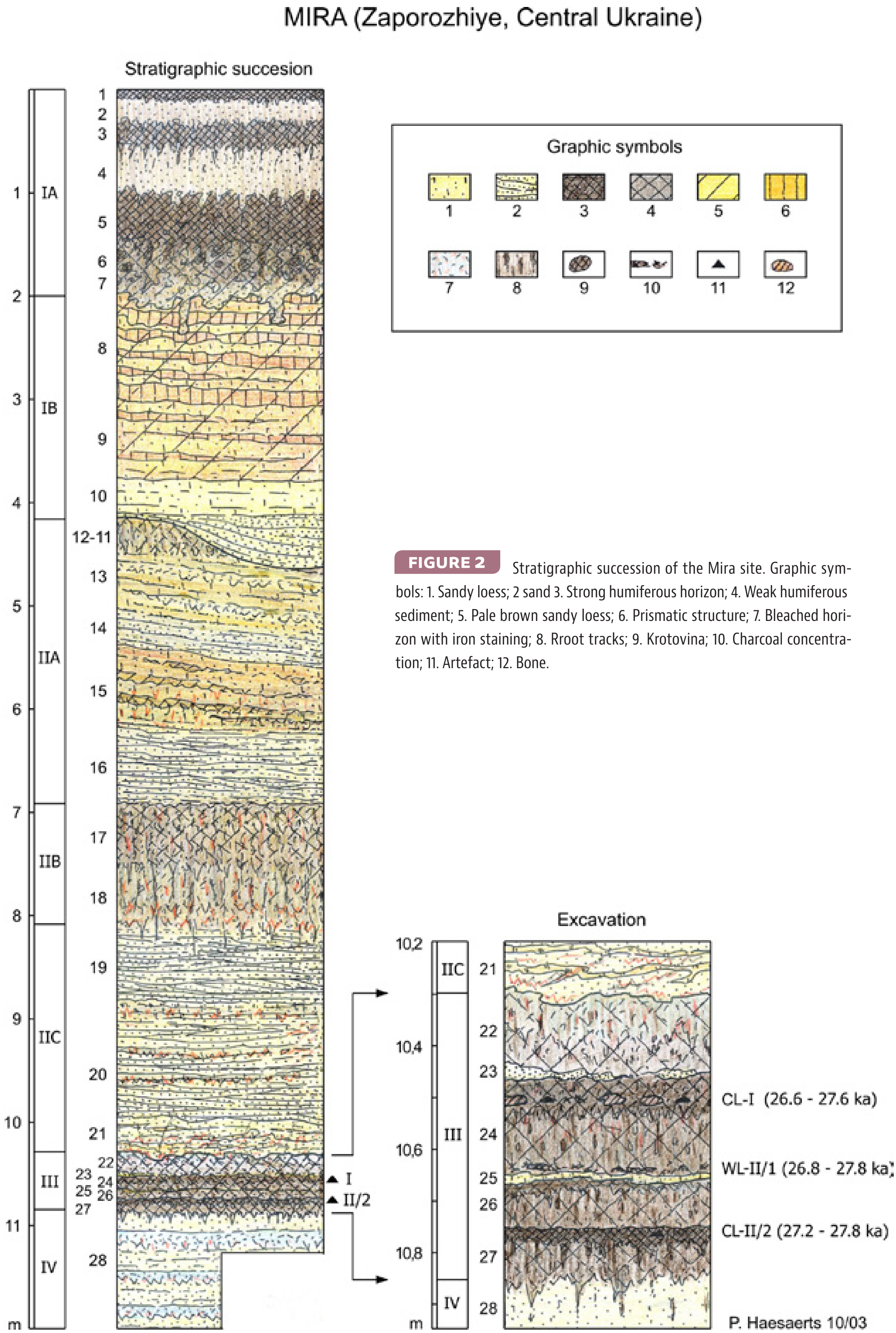


FIGURE 2 Stratigraphic succession of the Mira site. Graphic symbols: 1. Sandy loess; 2 sand 3. Strong humiferous horizon; 4. Weak humiferous sediment; 5. Pale brown sandy loess; 6. Prismatic structure; 7. Bleached horizon with iron staining; 8. Rroot tracks; 9. Krotovina; 10. Charcoal concentration; 11. Artefact; 12. Bone.

- L 16 (6.20 to 6.90 m) - Light grey sand horizontally stratified, with fine cross-bedding; sharp and erosional lower limit. The top of the sand is cut downslope by the base of layer 15.

Subunit IIB (layers 17 and 18: 6.90 to 8.10 m)

2.4

- L 17 (6.90 to 7.60 m) - Brown, mottled sandy loam with spots of iron hydroxides and gley patches. The matrix of this horizon is weakly humic, compacted, with prismatic structure, abundant worm burrows and iron-stained root tracks; gradual lower limit.

- L 18 (7.60 to 8.10 m) - Greyish iron-stained compacted loamy sand with abundant concretions and Mn staining. The lower limit of this hydromorphic horizon is gradual, underlined by iron hydroxides.

Subunit II C (layers 19 to 21: 8.10 to 10.30 m)

2.5

- L 19 (8.10 to 9.50 m) - Light grey fine sands with horizontal and diagonal laminations.

- L 20 (9.50–10.00) - Light grey sands with thick diagonal and horizontal bedding. The sands are fine grained and contain thin grey silty bands with iron hydroxides. The lower boundary is erosional. Locally the sands are disturbed by involutions and penetrate into the underlying layer L 21 along thin cryo-desiccation cracks up to 30 cm deep.

- L 21 (10.16–10.30 m) - Alternation of greenish-grey silty bands and white sandy bands; the beds were subjected to involutions and form a net of loops and pockets. The sediments are crossed by ochre strips of iron hydroxides; the lower contact is sharp and undulated.

Unit III (layers 22 to 27: 10.30 to 10.85)

2.6

- L 22 (10.30 to 10.44 m) - Grey compacted sandy loam; poorly developed mottled gley with dark grey worm burrows and iron staining along root tracks, thin soot interlayers and scattered small charcoal fragments. The lower and upper limits are undulating at the contact with the white sands of layers 21 and 23.

- L 23 (10.44 to 10.47 m) - Thin layer of white fine sand filling dessication-cracks. In places, it is substituted by pale yellow sandy loam up to 0.2 m thick, crossed by ochre bands and worm burrows.

- L 24 (10.47 to 10.64 m) - Pale brownish grey sandy loam mottled and strongly bioturbated, with iron staining, small white sandy spots and fragments of charcoal. The upper part (10,47 to 10.53 m) is more humiferous and has a darker colour; this A1 horizon includes cultural layer I at the depth of 10.50 m: bones, lithic implements and charcoal are horizontally distributed along one continuous concentration. A second concentration of charcoal is present in the lowermost part of layer 24 (wood layer II/2), occurring as a set of burnt branches, some of them being inter crossed; no archaeological evidence nor bones were observed at this level.

- L 25 (10.64–10.68 m) - Thin layer of light grey sand, passing laterally to pale yellowish grey sandy loam. The lower limit is sharp, with small sandy pockets.

- L 26 (10.68–10.73 m) - Pale brownish grey sandy loam similar to layer 24; locally the upper part of layer 26 is underlined by a thin greyish brown horizon, with bioturbated lower limit.

- L 27 (10.73–10.85 m) - Pale brownish grey silty sand, mottled with abundant worm burrows and root tracks; the lower limit is distinct, with small pockets of sand injections. On top, layer 27 shows a distinct 0.05 m thick dark grey strongly bioturbated horizon, almost continuous; it contains the second cultural layer (Cl-II/2) characterised by a linear concentration of charcoal with some bone fragments and scattered lithic implements.

Unit IV **2.7**

- L 28 (10.85 to 14.85 m) - Light grey fine sand, horizontally bedded and light greenish grey sandy loam beds with worm burrows, iron hydroxides bedding and injections of the grey sand.

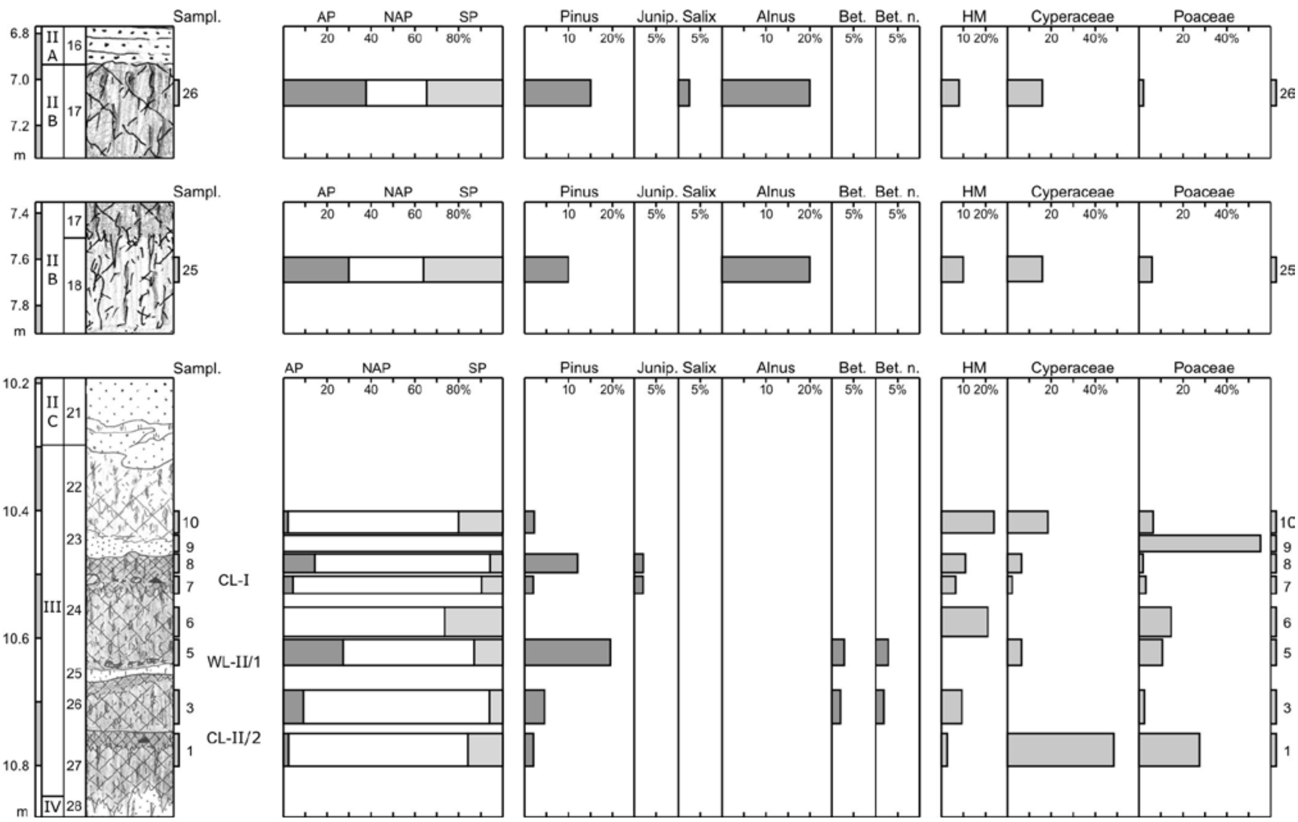
3 ANTHRACOLOGY (F.D.)

3.1 Origin of the Material and Methods

Various samples of loamy sediment from unit III containing charcoal were collected for dating by the excavators in 2000. Three of theses samples were taken back to Belgium in June of 2001 by one of us (PH) with the aim of selecting the best material for charcoal analysis and dating.

A first sample was taken out of the archaeological layer I in the upper third of geological layer 24 (**figures 2** and **4**). The second sample comes from the concentration of burnt wood remains labelled II/1 just at the base of the same layer 24 but this time without artefact. This accumulation was made of various carbonised wood remains comprising brittle inter crossed branches. Lastly, the third sample was collected in the upper part of layer 27 which contained cultural layer II/2.

FIGURE 3 (Mira) – Polllen diagram of units III and II.



Charcoal was prepared and selected following the specific methodology presented in Damblon & Haesaerts 2002: separation of charcoal from sediment by water with sodium pyrophosphate, cleaning charcoal by acids (HF, HCl), charcoal extraction by sieving at each step, drying of charcoal fragments, identification with binocular and microscope and finally selection of the best fragments for dating.

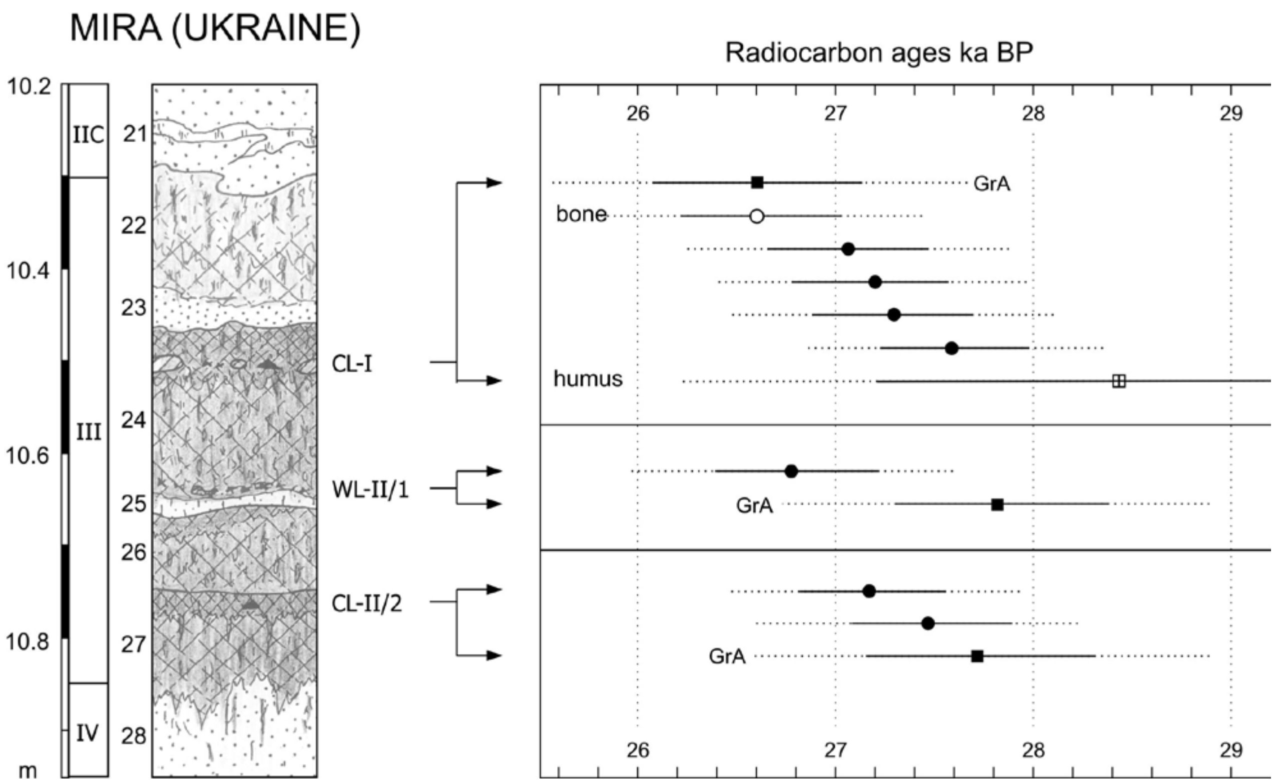
3.2 Charcoal Analysis

All fragments of charcoal and burnt wood from the three layers belong to the same taxon, the Scot's pine type, which can be recognised notably by the resin canals with soft thin-walled epithelial secretory cells (most often destroyed in charcoal), by the two or three superposed lines of ray tracheids, by the large window-like pit (pinoid pit) on the parenchyma cells of the cross fields and by the numerous tooth-like structures on the wall of the ray tracheids (**figure 5**: 1–6). It is worth to recall that Scot's pine anatomical type of wood is encountered in both species *Pinus sylvestris* and *P. mugo* (see notably Schweingruber 1990).

These speciescorrespond to some different ecological conditions but, for the region of Southern Ukraine and for the period considered, it seems difficult to decide which is the best candidate. Moreover, by numerous charcoal fragments from the three samples, the transversal section presented a very sharp transition from early to latewood (**figure 5**: 6) suggesting contrasted ecological conditions. Both pines are able to survive in hard environments and are adapted to withstand low temperatures, strong winds, snow and dryness.

It is also worth to point out the occurrence of micro-charcoal in the pollen slides (see N.G., § 4) prepared from layer 27 (cultural layer II/2) and base of layer 24 (wood layer II/1). Moreover, a number of *Pinus* pollen air-sacks were black-burnt testifying wildfires in springtime. Together with charred remains of pine branches this shows the importance od wildfire at the regiona scale.

FIGURE 4 Groningen (GrA) and Kiev (Ki) radiocarbon dates: Groningen dates on charcoal (black square); Kiev conventional date on humus (crossed square); Kiev conventional dates on charcoal (black circles); Kiev conventional date on bone (white circle); one sigma (full line); two sigmas (dotted line).



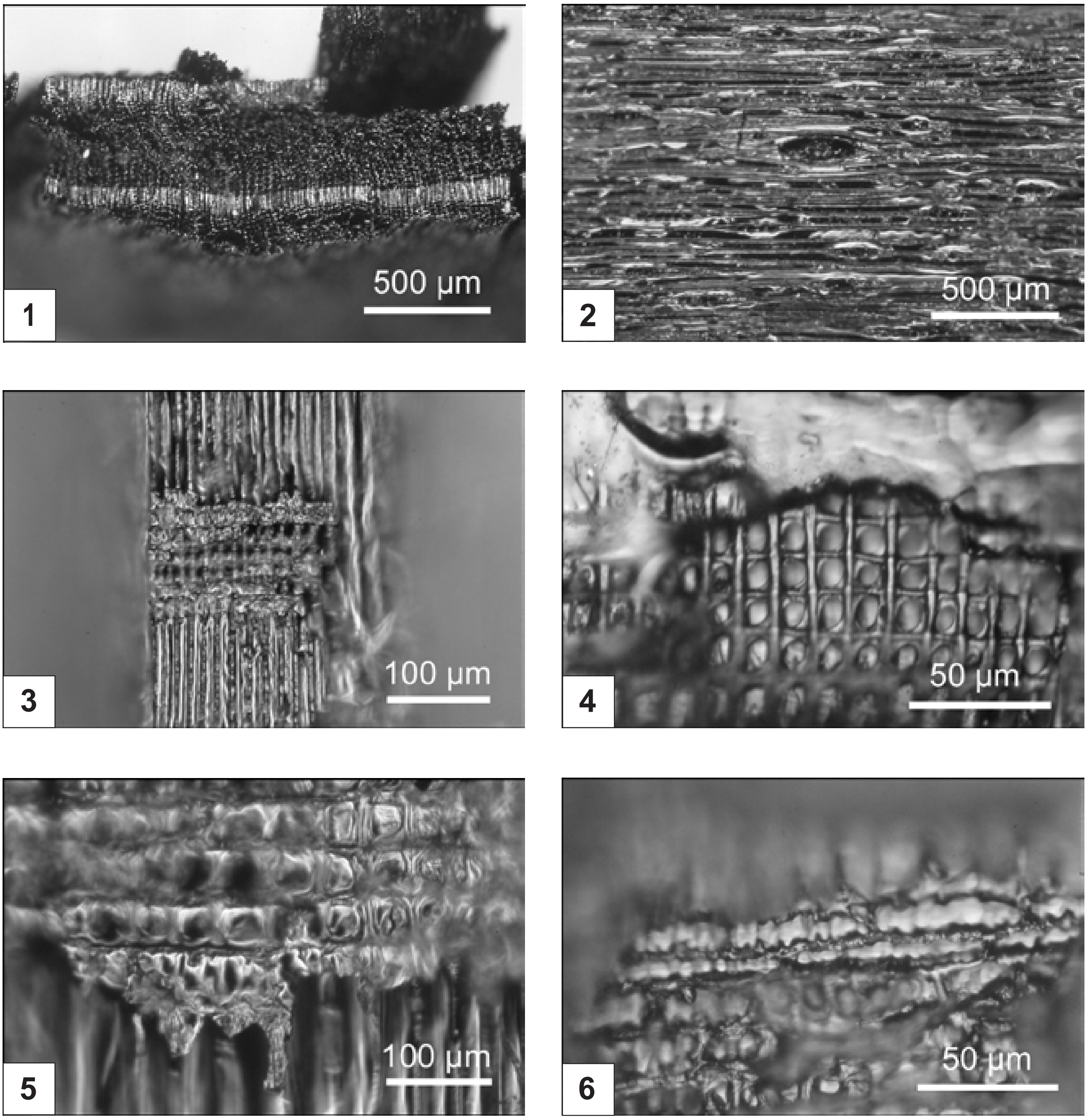


FIGURE 5 *Pinus sylvestris*-type of charcoal. Anatomy of the structures in transversal, tangential and radial sections: 1. Transversal section showing sharp transition from early (black zone) to late wood (whitish zone); (wood layer II/1, A–1085); 2. Tangential section (turned to 90°) with one resin canal and multiple uniseriate rays cut transversally; (wood layer II/1, A–1085); 3. Radial section showing an horizontal ray crossing vertical tracheids. window-like pits are visible on the three lines of parenchyma ray cells bordered upwards and downwards by two lines of ray tracheids; (wood layer II/1, A–1085); 4. Radial section showing cross fields with large window-like pinoid pits; (cultural layer I, A–1084); 5 & 6. Radial sections showing ray tracheids with areolate pits and tooth-like structures on the walls of the ray tracheids (cultural layer I, A–1084).

4 PALYNOLOGY (N.G.)

4.1 Pollen Data

Only small amounts of microfossils have been extracted from specific layers of the Mira section, (**figures 3** and **6**) respectively from unit III (layers 27 to 22) and subunit IIB (layer 18 and 17). Moreover, all charcoal samples analysed from both cultural layers (II/2 and I) and from the layer of burnt wood (II/1) belong to *Pinus* (*cf.* § 3).

In unit III, the humiferous horizon of layer 27 (sample n°1) with cultural layer II/2 provided 34 pollen grains; they belong mainly to Cyperaceae, Poaceae (Gramineae) and a single Rosaceae; few spores of Bryales and Lycopodiaceae, and one pollen grain of *Pinus* were also present together with abundant micro-fragments of charcoal (**figures 3** and **6**).

FIGURE 6 Pollen counts from units III and II of Mira.

UNITS	III	III	III	III	III	III	III	III	II	II
LAYERS	27	26	24	24	24	24	23	22	18	17
DEPTH (M)	10.75–10.8	10.68–10.73	10.60–10.64	10.55–10.6	10.50–10.53	10.47–10.5	10.44–10.47	10.40–10.44	7.60–7.70	7.00–7.10
SAMPLE NUMBER	1	3	5	6	7	8	9	10	25	26
Pinus	1	4	5	-	1	5	-	1	3	7
Juniperus	-	-	-	-	1	1	-	-	-	-
Salix	-	-	-	-	-	-	-	-	-	1
Alnus	-	-	-	-	-	-	-	-	6	10
Betula sect. Albae	-	2	1	-	-	-	-	-	-	-
Betula sect. Nanae	-	2	1	-	-	-	-	-	-	-
Subtotal AP	1	8	7	-	2	6	-	1	9	18
Brassicaceae	-	1	-	-	-	-	-	-	-	-
Apiaceae	-	1	-	-	-	1	-	3	-	-
Lamiaceae	-	2	-	-	3	-	-	-	1	1
Ranunculaceae	-	1	-	3	-	2	-	2	-	-
Rosacae	1	3	-	4	-	2	-	4	2	3
Asteroideae	-	35	6	9	29	23	-	9	-	-
Cichorioideae	-	22	-	-	-	-	-	-	-	-
Artemisia	-	3	4	2	-	-	8	-	-	-
Ephedra	-	-	-	-	-	-	1	-	-	-
Poaceae	10	2	3	5	2	1	12	3	2	1
Cyperaceae	17	-	2	-	1	3	-	7	5	8
Butomaceae	-	-	-	-	1	-	-	-	-	-
Subtotal NAP	28	70	15	23	36	32	21	28	10	13
Bryales	-	3	3	8	4	2	-	7	6	7
Filicales	2	-	-	-	-	-	-	-	4	9
Lycopodiales	3	1	-	-	-	-	-	-	-	-
Subtotal Spores	5	4	3	8	4	2	-	7	10	16
Total	34	82	25	31	42	40	21	36	29	47

AP: Arboreal pollen; NAP: Non arboreal pollen

Layer 26 (sample n°3) is the richest in pollen in the section, with 82 pollen grains. Herbaceous pollen group strongly dominates with diverse composition and good preservation: Poaceae, Ranunculaceae, Brassicaceae, Rosaceae, Lamiaceae, Apiaceae, Asteroideae, Cichorioideae and *Artemisia*. Almost 68 % pollen grains of this herbaceous group belong to the Asteroideae sub-family with mainly pollen type of *Eupatorium* and 20 % of Cichorioideae. Rosaceae and *Artemisia* are next in abundance. Arboreal pollen grains (10 %) are represented by *Pinus* and *Betula* in equal portions, some pollen grains of *Pinus* with black air-sacks being probably burnt; pollen grains of *Betula* sp. and of *Betula* sect. Nanae et Fruticosae as well as few spores of Bryales and Lycopodiaceae were also observed.

In layer 24 (sample n°5), the lower part with burnt branches (cultural layer II/1) provided only 25 pollen grains, including *Pinus*, *Betula*, Poaceae, Cyperaceae, Asteroideae, *Artemisia* and Bryales; 11 pollen grains of *Pinus* have burnt air-sacks. One pollen grain of *Betula* belongs to *Betula* sect. Nanae et Fruticosae. As for layer 27, the sample contained many micro-fragments of charcoal.

The middle part of layer 24 (sample n°6) contained a total of 31 pollen of herbs and Bryales spores; the herbs are represented by Poaceae, Ranunculaceae, Rosaceae, Asteroideae and *Artemisia*.

The upper part of layer 24 (sample n°7) with archaeological layer I yielded 42 pollen grains

with abundance of Asteroideae and single grains of *Pinus*, *Juniperus*, Poaceae, Cyperaceae, Lamiaceae, Butomaceae and Bryales.

The uppermost part of layer 24 (sample n°8) provided 40 pollen grains; the proportion of *Pinus* pollen grains is higher at this level (14 %) and some of them have black air-sacks. Asteroideae dominates in herbaceous pollen together with few Poaceae, Cyperaceae, Ranunculaceae, Rosaceae and Apiaceae.

In the thin sandy deposit of layer 23 (sample n°9) only 21 pollen grains of Poaceae, *Artemisia* and a single *Ephedra* were extracted.

In layer 22 (sample n°10) the lower part of the gley yielded 36 pollen grains of various herbs: Poaceae, Cyperaceae, Rosaceae, Lamiacaeae, Apiaceae, Asteroideae, Cichorioideae, with Cyperaceae and Asteroideae dominating. One pollen grain of *Pinus* and relatively abundant Bryales spores were present.

In the hydromorphic horizons of subunit IIB, layers 18 (sample n°25) and 17 (sample n°26) provided respectively 29 and 47 arboreal pollen, herbaceous pollen and spores in equal proportions. The arboreal pollen consists of *Pinus*, *Alnus* (dominating) and one grain of *Salix*; herbaceous pollen includes Cyperaceae (dominating), Poaceae, Rosaceae and Lamiaceae; Polypodiaceae spores are also relatively abundant.

4.2 Interpretation

The small pollen number in each layer allows only a tentative reconstruction of the vegetation evolution at the Mira site. Despite this situation, the successive palynological records give valuable information on the plant cover, mainly during deposition of unit III, which was dominated by herbs (**figure 3**).

During the development of the humiferous horizon of layer 27 containing the cultural layer II/2, Poaceae and Cyperaceae coenoses existed on the flood plain. Later, during deposition of layer 26, meadow vegetation started to spread with the development of diverse Herbetum mixtum. At that time Poaceae were covering the low part of the flood plain near the river channel, whereas Herbetum mixtum meadow occupied the central part of the flood plain, with more stable surface and betterdeveloped soil cover. At this level the share of Asteroideae and Cichorioideae is very high; these families include psammophyts and plants growing on fresh alluvial surfaces. The dominance of Asteroideae pollen is in a good correspondence with the initial pedogenic processes. Despite the alluvial component of layer 26, the 10 % of *Pinus* and *Betula* pollen grains could be interpreted as a possible presence of these trees in the vicinity of the site.

During deposition of layer 24, a same type of vegetation existed around the site. Still, the presence of burnt branches of pine at the base of the deposit (wood layer II/1) forms direct evidence that this tree participated in the vegetation cover of the region (*cf.* § 5). In the sediment above the level of burnt branches (sample 6), arboreal pollen grains were not observed and *Betula* pollen does not reappear higher up. Concerning the upper part of layer 24 (cultural layer layer I), the extensive distribution of Asteroideae sub-family plants occurred firstly. Pollen grain of Butomaceae indicates the periodical flooding of the site. Later on, meadow Herbetum mixtum sbsisted with probable presence of pine in the site vicinity, accompanied by heliophytic shrub *Juniperus*, but without *Betula*.

Further, the dominance of steppic elements with *Ephedra*, *Artemisia* and Poaceae and absence of Herbetum mixtum in the sandy layer 23 could be ascribed to an increase of aridity. Nevertheless, as layer 23 records an episode of high flood, one may consider that this dominance is not related to local vegetation but to fluviatile supply from the regional steppe background. On the contrary, the pollen assemblage of layer 22, related to meadow vegetation, reflects again local situation during the formation of the gley loam.

Finally, during the development of the hydromorphic horizons of subunit IIB (layers 18 and 17), pollen data shows the presence of *Alnus* associations with Polypodiaceae ferns in undergrowth on the river side, a type of vegetation rather different from the meadow communities existing during the formation of unit III.

From the whole pollen sequence it seems that the regional steppe landscape, with scattered pine (*Pinus*) as main tree components, did not vary fundamentally while variations in the fluvial regime during the period considered had influenced the plant cover on the river bank and flood plain where meadows and riparian communities developed. The occurrences of alder (*Alnus*) and willow (*Salix*) pollen in unit II point to local more humid conditions. In the same time, it seems that the steppe landscape was submitted to frequent wildfires as suggested by occurrences of micro-fragments of charcoal and black air-sacks of pine in the unit III.

5 RADIOCARBON DATES (F.D. & P.H.)

Results

5.1 Up to now, nine conventional radiocarbon dates were obtained in the Kiev laboratory (Ki-) and three AMS in Groningen GrA-), the latter ones on the samples analysed for charcoal in Brussels. The aim of the present chapter is to discuss both sets of comparable dates (**figure 7**).

The three AMS Groningen dates are shown in **figure 7** together with the conventional Kiev dates. **Figure 8** gives the results of calibration based on OxCal and CalPal.

N°	GEOLOGICAL LAYER	LAYER	MATERIAL	C WEIGHT DATED (G)	N° DATE	^{14}C AGE (BP)	CAL AGE (BP CALPAL	CAL AGE (BP) OXCAL
1	III–24 upper part	CL-I	*Pinus* charcoal	0,4	GrA–20019	26,590 ± 490/460	30,802 – 31,747	30,803 – 31,416
2			bone	-	Ki–10283	26,610 ± 400	30,847 – 31,729	30,890 – 31,375
3			charcoal	-	Ki–10284	27,080 ± 400	31,441 – 32,089	31,107 – 31,635
4			charcoal	-	Ki–8153a	27,200 ± 380	31,614 – 32,149	31,157 – 31,720
5			charcoal	-	Ki–8154	27,300 ± 390	31,692 – 32,325	31,195 – 31,860
6			charcoal	-	Ki–8152	27,600 ± 370	31,897 – 32,627	31,350 – 32,189
7			soil	-	Ki–8381	28,450 ± 1100	–	–
8	III–24 base	WL-II/1	charcoal	-	Ki–8155	26,800 ± 390	30,995 – 31,855	31,015 – 31,450
9			*Pinus* charcoal	0,65	GrA–20020	27,830 ± 580/540	31,983 – 33,004	31,472 – 32,758
10	III–27 upper part	CL-II/2	charcoal	-	Ki–8156	27,200 ± 360	31,632 – 32,173	31,168 – 31,684
11			charcoal	-	Ki–8201	27,510 ± 400	31,833 – 32,577	31,289 – 32,128
12			*Pinus* charcoal	0,22	GrA–20033	27,750 ± 590/550	31,928 – 32,948	31,414 – 32,691

FIGURE 7 (Mira) – Radiocarbon dates from stratigraphic unit III: cultural layers I and II/1, wood layer II/2.

The three Groningen dates (GrA-) seem to be ordered in two sets with one date around 26 600 BP in cultural layer I and two dates around 27 800 BP in wood layer II/1 and cultural layer II/2 (**figure 4**). However, such a distribution is not so clear when considering the nine conventional dates (Ki-) obtained on charcoal, bone and humus by the Kiev laboratory. Indeed, the distribution of the six Kiev dates in cultural layer I ranges from 28 450 BP up to 26 610 BP whereas the GrA date (26,590 BP) is the youngest one. Moreover, the four Kiev dates on charcoal show regular distribution between 27 600 and 27 080 BP. In other respects, in wood layer II/1, the two dates of 27 830 and 26 800 BP are separated by about one millennium whereas in cultural layer II/2 the three dates appear more regrouped between 27 750 and 27 200 BP.

Discussion 5.2

The first question is to understand the significance of the pine charcoal concentrations in the successive layers. In cultural layer I, charcoal is clearly associated with hearth structures, bone remains and flint artefacts. In cultural layer II/2, charcoal is also associated with bone and artefacts. Clearly the charcoal concentrations in both cultural layers come from wood collected by man.

On the contrary, in wood layer II/1, charcoal is not associated with artefact and cannot be considered of anthropic but rather of natural origin. Moreover, the local concentration of brittle burnt remains of branches with ramifications strongly suggests that charcoal material from sample dated in Groningen comes from local trees or wood debris which had burned *in situ* due to wildfire. Notice here that this layer II/1 contained the highest amount (20 %) of *Pinus* pollen in the sequence largely dominated by steppe herbs (see N.G. § 4). This pollen record may be interpreted as a result of scattered trees in the region whilst charred brittle branches rather point to local burnt wood. This may also explain the incomplete carbonization state of the charred wood remains in layer II/1. Consequently the charred wood remains are considered contemporaneous to the sedimentation phase.

In cultural layer I, the growing ages of the five dates on charcoal may come from successive inputs of wood debris on the river bank and this leads to infer that man, following the law of the least effort (Shackleton & Prins 1992), collected drift wood for fuel notably dead wood pieces reworked by the river from older deposits along the banks and deposited by flooding. This of course will have consequences in the interpretation of the radiocarbon data.

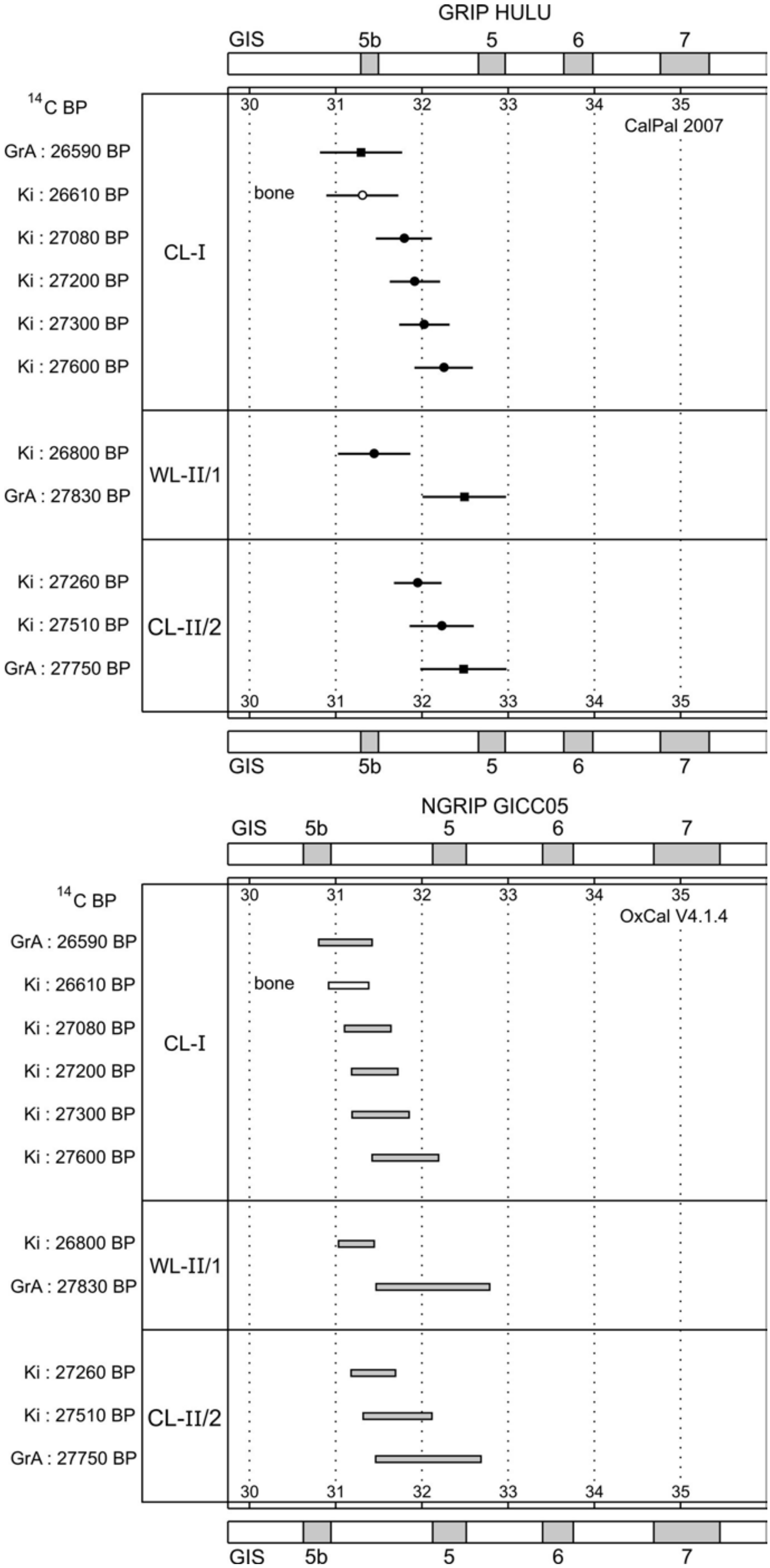


FIGURE 8 (Mira) – Calibration ages following CalPal (A) versus $NGRIP_{HULU}$ (Weninger & Jöris 2008) and OxCal (B) versus NGRIP GICC05 (Svensson *et al.* 2006).

The fact that the GrA date 27,750 BP in cultural layer II/2 appears very close to GrA date 27,830 BP in wood layer II/1 suggests very fast sedimentation process. This reinforces the scenario of a rapid sedimentation rate in stratigraphic unit III. Other arguments to interpret the set of dates in cultural layer II/2 are discussed below.

A second question which comes from the comparison of the AMS results from Groningen with the conventional dates obtained in the Kiev laboratory (**figure 4**) is how to interpret the whole set of radiometric data. The first problem is to evaluate the significance of the GrA and Ki dates. It is important here to stress the fact that the accuracy, precision and reproductibility of the GrA dates were positively tested on charcoal in various loess sites from west and central Europe to Siberia (Haesaerts *et al.* 2005, 2010).

In cultural layer I, the GrA date 26 590 BP is the youngest one with regard to the Ki dates (from 27 600 to 27 080 BP), taken apart the date on bone (Ki–10283: 26 610 BP) from the same layer and the date Ki–8381 28 450 ± 1 100 BP on humus which appears too old and shows a too large σ uncertainty. Such a dispersion of the Ki dates may originate from either statistical differences linked to the Kiev laboratory or from the use of drift older wood supply by Palaeolithics. This latter hypothesis is more convincing with regard to stratigraphical data and the comparison of the radiocarbon dates in the whole sequence. Consequently the GrA date on charcoal and the Ki date on bone appear in good agreement and the most probable for the human occupation in cultural layer I

In cultural layer II/2, the Ki dates show a coherent distribution over a time period of ca 1 000 years. In the present context, the GrA date 27 750 BP seems acceptable and appears to be contemporaneous with the formation of the humic horizon when the Ki dates are younger and show overlap for 2 Ki dates over a time-lag of ca 500 years.

Now a last question is the identification of climatic events recorded in the sequence.

First notice that cultural layers II/2 and I are both directly associated with a well developed humiferous horizon which point to a stabilization phase of the alluvial plain with an herbaceous plant cover (see P.H. & N.G. § 4). Yet, in Eastern Europe (East Carpathians, Kostienki), this type of pedogenesis has been associated to interstadial phases notably between 30 and 25 ka BP and put in parallel with the Greenland Interstadial Stages (GIS) 7, 6, 5 and 5b of the ice sequences (Haesaerts *et al.* 2009, 2010).

The present hypothesis can be tested by calibration of the GrA and Ki dates as shown in **figure 8** following two different systems. The CalPal system is a reference system based on the chronological scale of the GIS (GreenlandInterStadial) events in the NGRIP sequence but constrained and matched by the Hulu cave sequence (Weninger and Jöris 2008). The OxCal system (v.4.1.4) is based on the chronological scale of the GIS events in the NGRIP sequence (Svensson *et al.* 2006) referring to Incal 9 (Reimer *et al.* 2009). **Figure 8** clearly shows differences in the distribution in time of the climatic events GIS 5 and 5b between 30 and 33 ka BP.

Here the CalPal calibration points to a correspondence of archaeological occupations I and II/2 with GIS 5b and 5 respectively. Such a distribution in time is in a very good agreement with the pedosedimentary record where each cultural layer is embedded in a humic horizon pointing to climate improvement.

On the contrary, the OxCal calibration leads to time intervals in the event GIS 5 for cultural layer II/2 whilst the cultural layer I fits with a cold period between GIS 5 and 5b. This latter correlation cannot be accepted as charcoal concentration and artefacts were also included in a humifc horizon.

In conclusion, the CalPal Calibration system appears in the present situation as the most adequate in agreement with the pedosedimentary record at Mira where cultural layers II/2 and I both occurred in a well developed humic horizon. In this manner, the cultural layer II/2 can be attributed to the interstadial episode GIS 5b evaluated ca 31.3 cal BP while the cultural layer I may be attributed to the interstadial event GIS 5 around 32.5 cal BP.

6 Environmental evolution (N.G. & P.H.)

The combined information on stratigraphy, sedimentology, pedology, palaeobotany and radiocarbon chronology gained for the Mira sequence allow a first attempt to reconstruct the palaeoenvironmental evolution; this approach takes into account the situation of the site along the Dnieper River, downstream the narrowing of the valley north of Zaporozhiye.

6.1 Unit IV (layer 28)

The sandy deposits of layer 28 correspond to the alluvial suite of the Dnieper terrace; it belongs to the upper part of channel alluvium at the transition to the overbank facies.

6.2 Unit III (layers 27 to 22)

This unit shows the overbank facies of the terrace alluvium with interbedded three initial humic soils (the top of layers 27, 26 and the upper part of the layer 24). Each A1 horizon of these soils marks stable surface of the flood plain and relatively low and infrequent floods, whereas the sandy bands in between (layers 25 and 23) mark high floods.

The Palaeolithic man settled firstly on the flood plain during the soil formation at the top of layer 27 (cultural layer II/2). The second evidence of presence of man at the site corresponds to cultural layer I at the base of the A1 horizon of layer 24. Both cultural layers thus belong to the soil-sedimentary processes; they were probably buried quickly after the occupation, this situation providing good preservation of the remains of human activities. In both cases the camp sites were located in the alluvial plain of the Dnieper, at some distance from the valley slope, probably in the vicinity of the fluviatile channel.

The A1 horizon of the soil related to the first Palaeolithic occupation (II/2) on top of layer 27 is most expressed, although rather thin. Humus accumulation and rather intense bioactivity were typical for the pedogenesis. At that time, pioneer vegetation with grasses and sedges occupied the site and obviously produced the well developed humic layer. Later, it was buried by the overbank alluvium.

The second alluvial soil (top of the layer 26) is poorly developed, discontinuous and more gleyed. It was formed under meadow coenoses. Diverse herbs grew in the site surroundings, but representatives of Asteroideae and Cichorioideae sub-families, less demanding to the soil fertility and surface stability, strongly dominated. Arboreal vegetation of the site vicinity was not abundant and included probably a few pines and birches, together with arcto-boreal shrub forms of birch. The soil was buried under the high flood-plain deposition of layer 25.

As demonstrated by the *Pinus* burnt wood concentration, the pine was growing locally during the deposition of lower part of layer 24. After some input of overbank alluvium (middle part of the unit 24), meadow vegetation prevailed when Palaeolithic man settled for the second time on the site (cultural layer I); this type of plant community continued during the period of soil formation in the upper part of layer 24, firstly strongly dominated by Asteroideae plants, later on possibly with occurrence of pine and juniper in the vincinity.

Layer 23 records the input of silt and overbank sands on the flood-plain, together with a noticeable share of *Artemisia* and presence of *Ephedra* in vegetation cover. Such extent of steppic elements in layer 23, tentatively ascribed to an increase of climatic aridity, could rather reflect regional background related to the high flood fluviatile supply.

Nevertheless, meadow vegetation is again present on the flood plain during the development of the gley soil with strong water logging in the upper part of layer 22. This soil is also affected by distinct cryogenic features which might announce the start of the important cooling recorded in the overlying subunit IIC

Altogether, unit III records a rather homogeneous set of overbank sedimentary events with development of ephemethral humiferous soils, under meadow vegetation reflecting a relatively cool climate; this is also indicated by the poor diversity of boreal-tree taxa and their low contribution to the vegetation cover. According to the radiometric dates of layers 27 and 24 (see § 5), deposition of unit III should fit in between ca 28.000 and 26.000 BP, a period which corresponds to the gradual transition through the boundary between Middle and Late Pleniglacial (*cf.* § 8).

Subunit IIC (layer s 21 and 20)

6.3 Layers 20 and 19 show the transition from flood plain to channel facies with sedimentation of cross-bedded sands, cryoturbation and secondary enrichment in iron hydroxides connected with water logging in the lower part (layer 20). The river flow (or one of its channels) came again to the area, the change in the hydrological regime being possibly controlled by climatic cooling; the cryoturbation observed at the base of the sequence, might confirm this suggestion.

Subunit IIB (layers 18 and 17)

6.4 This subunit demonstrates two hydromorphic soils, developed on the flood plain. The lower one is a weak initial gley soil, formed on sandy substratum, with abundant manganese concretions. The upper soil is better pronounced, strongly gleyed, but with some humus accumulation and soil structure, abundant worm routes and root tracks. The vegetation was dominated by alder groves with Polypodiaceae ferns in undergrowth; few willows and sedges also occurred. Soil characteristics and hygrophytic type of vegetation indicate a rather wet local environment under cool climate, possibly during a weak interstadial.

Subunits IIA and IB (layers 16 to 12 and layers 11 to 8)

6.5 These subunits record a first set of sub-aerial sediments following up the alluvial suite of subunits IIC and IIB. The lower part of subunit IIA consists of horizontally layered aeolian sands (layer 16) that gives evidence of intense wind activity and depletion of vegetation cover on the terrace surface, following a lateral migration of the river in its alluvial plain.

On the other hand, layers 15 to 13 combine aeolian deposits, pedosediments and initial soils, recovering the valley slope after the surface of the terrace was cut by a gully. Gleying, biologic activity and development of tiny brown sandy soil, recorded at this level together with the erosive processes, demonstrate some increase in climatic humidity. This set of sedimentary events ends with an initial soil developed on the slope, characterised by weak humus accumulation (layer 12), possibly related to a short interstadial.

After the formation of the initial soil, a new gully filled with sand (layer 11) developed on the valley slope demonstrating again sedimentary processes dominated by wind dynamics, as well as poor vegetation cover. Later on aeolian loamy sand and colluviated sediments completed the filling of the gully (layers 10 and 9–8 pro parte); these deposits were subjected to cryo-sorting, a process which provided a pronounced lamellar fabric of the sediments - a base for the banded Bt horizon recorded in layers 9 and 8. This horizon developed from the top of layer 8, belongs to the forest soil formed during Early Holocene (*cf.* P.H. & N.G. § 8). In Southern Ukraine this type of soil is related to a strong increase of edaphic humidity and high precipitation, as well as to the presence of a forest cover in the area at that time.

Subunit IA (layers 7 to 1)

6.6 The upper part of Mira sequence consists of three sandy deposits (layers 7, 4 and 2) alternating with humiferous soils (respectively layers 6 and 5, layer 3 and layer 1). The accumulation of sands above the forest soil of layer 8 reflects the return of dry conditions with an intense wind activity and formation of desiccation fissures on the Bt horizon surface.

The first humic soil (layers 6–5) can be regarded as a "borovoy chernozem", according to the nomenclature of the present soils of Ukraine; developed on sandy substrata, mainly on river terraces, this type of soil is usually formed under dense herb cover, sometimes with sparse pine woodlands. At that time the climate was very different from one of the Holocene forest pedogenesis, though still much wetter than during the sandy sedimentation of layer 7.

A second short period of climatic aridification corresponds to the sandy layer 4; it precedes the development of the chernozem-type soil of layer 3, which is less enriched in humus than the former one. Finally, sandy layer 2 shows the last aeolian input in the Holocene sequence, prior to the humus accumulation and biological activity of the surface soil (layer 1).

7 ARCHAEOLOGICAL OCCURENCES (V.S. & V.C.)

The sequence of Mira includes evidences of two Palaeolithic concentrations, namely cultural layer II/2 and I. The lowermost layer II/2 is associated with the thin humiferous horizon on top of layer 27, whilst cultural layer I occurs in the lower part of the weak humiferous horizon capping layer 24. Taphonomic study of data provided by cultural layers allows to conclude on very good state of preservation of archaeological remains and to emphasise the *in situ* character of both Palaeolithic layers (Stepanchuk & Cohen 2001; Stepanchuk *et al.* 2004).

Cultural layer II/2

7.1 This cultural layer preserved in the humiferous horizon of layer 27 was uncovered on an area of ca. 60 square meters. It provided several dozens of splintered bones of bison and wild horse and about 200 knapped flints related to several pits. The lithic industry includes backed blades of very original appearance (**figure 9**). Broad analogies of these implements may be seen in Gravettian assemblages (e.g. Otte 1985; Kozlowski 1986; Svoboda *et al.* 1996; Amirkhanov 1998). But the most close resemblance of Mira II/2 backed implements is provided by South Italian Aurignacian horizon 24A1 at Paglicci, proclaimed to be demonstrating evolutionary shift toward Gravettian (Palma di Cesnola 1996, 2000). Accordingly to its petrographic characteristics, the lithic material could originate somewhere from a locality of Western Ukraine, at least 350 km from Mira (Stepanchuk *et al.* 2009).

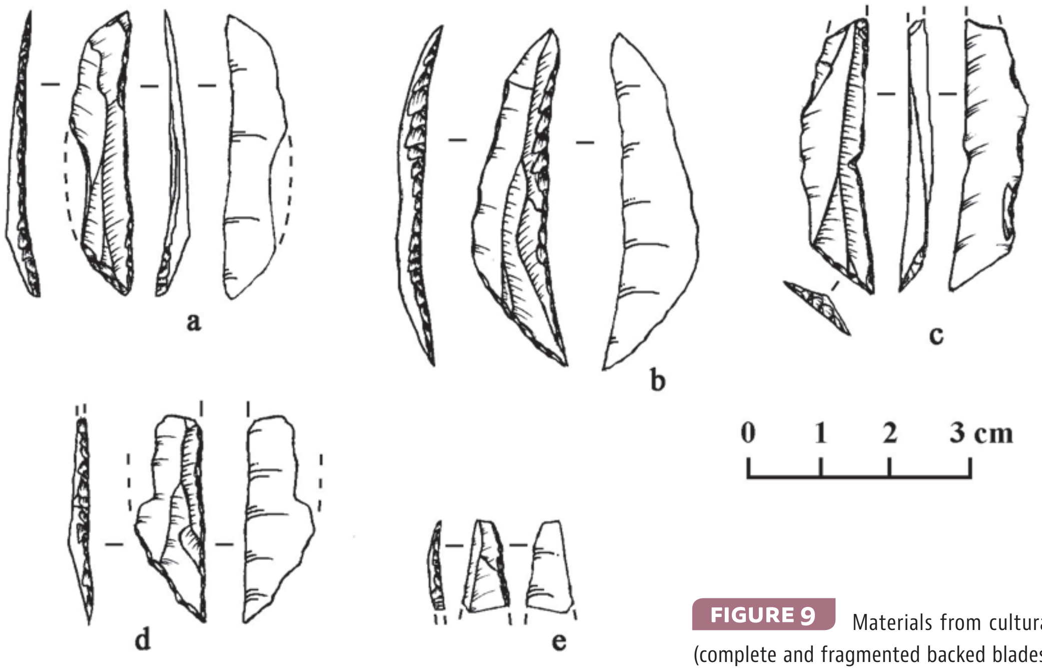


FIGURE 9 Materials from cultural layer II/2 (complete and fragmented backed blades of Paglicci 24A1 type).

Cultural layer I 7.2

The second archaeological layer excavated over about 50 square meters represents intensively utilised area with hearths, various pits, abundant paleontological remains and knapped flints (**figure 10**). To the contrary of West Ukrainian origins of flints from cultural layer II/2, peculiarities and original association of flints and rocks allow to recognise the East Carpathian origin of the main part of them. Presence of quantitatively rare typical flints, probably from valleys of main rivers located between East Carpathians Area and river Dnieper, might points to comparatively rapid migration.

Paleontological series provides predominant wild horse (71,8 % of NIB), following by fox, steppe and polar fox (21,6 %). *Asinus hydruntinus*, giant deer, red deer, reindeer, bison, mammoth and wild boar are represented but crucially subdominant. Composition of horse remains allow to reconstruct one episode of hunting on harem group of horses consisting of stallion accompanied by seven adults, two semi-adults and six young individuals. Peculiarities of spatial distribution of various pits, especially postholes and hearths, as well as localisation of "meaty" and "not-meaty" parts of skeleton of large animals, remains of carnivores, concentration of wastes of flint working etc… allow to reconstruct dwelling construction in the SE part of uncovered area. The distribution of the material suggests a permanent carcass spherical dwelling, opened to the river, with an area of ca. 15 sq. meters. Fragment of human molar identified as belonging to *Homo sapiens sapiens* was discovered inside the dwelling construction, together with the majority of pierced carnivore teeth and fragments of engraved bone pieces.

Flint industry comprises both Middle and Upper Palaeolithic features in technology and typology (**figure 11**). Flake products comprise both facetting butts and evidence of soft hammer stone technique. Middle Palaeolithic types are represented by points and side scrapers on flakes. The presence of canted points, various side scrapers, and both thinned side scrapers and points should be stressed.

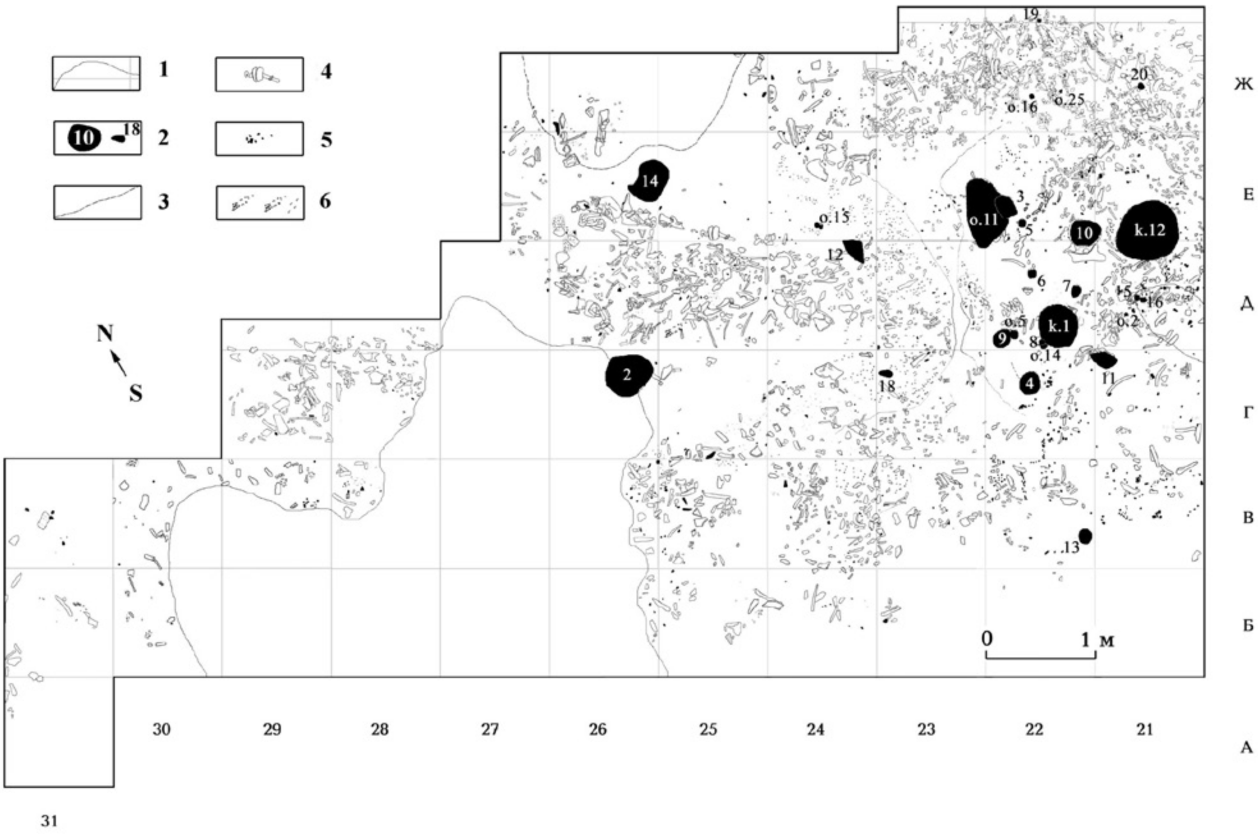


FIGURE 10 (Mira) – Cultural layer I, general plan of area exavated between 1995-2000. Graphic symbols: 1. Border of amateur excavations of 1995-1996; 2. Objects (pits, postholes, hearths); 3. Border of area saturated with tiny charcoals and ash; 4. Bones; 5. Lithics; 6. Wood charcoal.

Upper Palaeolithic types include micro-implements of Aurignacian appearance and highly original series of non-geometrical microliths. They are also represented by preponderant end scrapers, embracing several types, of which the most morphologically stable is sub-triangular end scraper with retouched laterals.

There are no Aurignacian high forms, though many of end scrapers are rather thick. Burins are few and show no extra-routine signs; angle burins prevail. Bifacial component includes plano-convex types similar to known in Middle Palaeolithic of Micoquian type and several leaf-points. There are numerous combined tools among which end scrapers point are very expressive. There are rather atypical inversely retouched lamelles and Krems-Dufour points, micro-truncations and series of morphologically unstable pieces with light, often partial, edge retouch.

Highly original feature of Mira cultural layer I assemblage consists in presence of large series of micro-flakes with blunted edges, either intentionally retouched or showing use-wear retouch. It cannot be excluded that the genesis of original micro-component of Mira layer I, as well as Aurignacian-related bladelet component, is rooted in hard scarcity of available raw materials and, therefore, represents example of independent innovation. By the other hand, it cannot be excluded the either direct or indirect impacts of outer “very likely Aurignacian” influences, which resulted just in the production of micro implements. In any case, currently available data is too scarce for solution the question. Lithic series is accompanied with numerous retouches made of fragments of long bones mostly typical for Middle Palaeolithic. Nevertheless, there are also fragmented points or awls and polishers. Probable bone pendant (or needle eye), remains of likely bone shaft and amber pendant complement the series of finds.

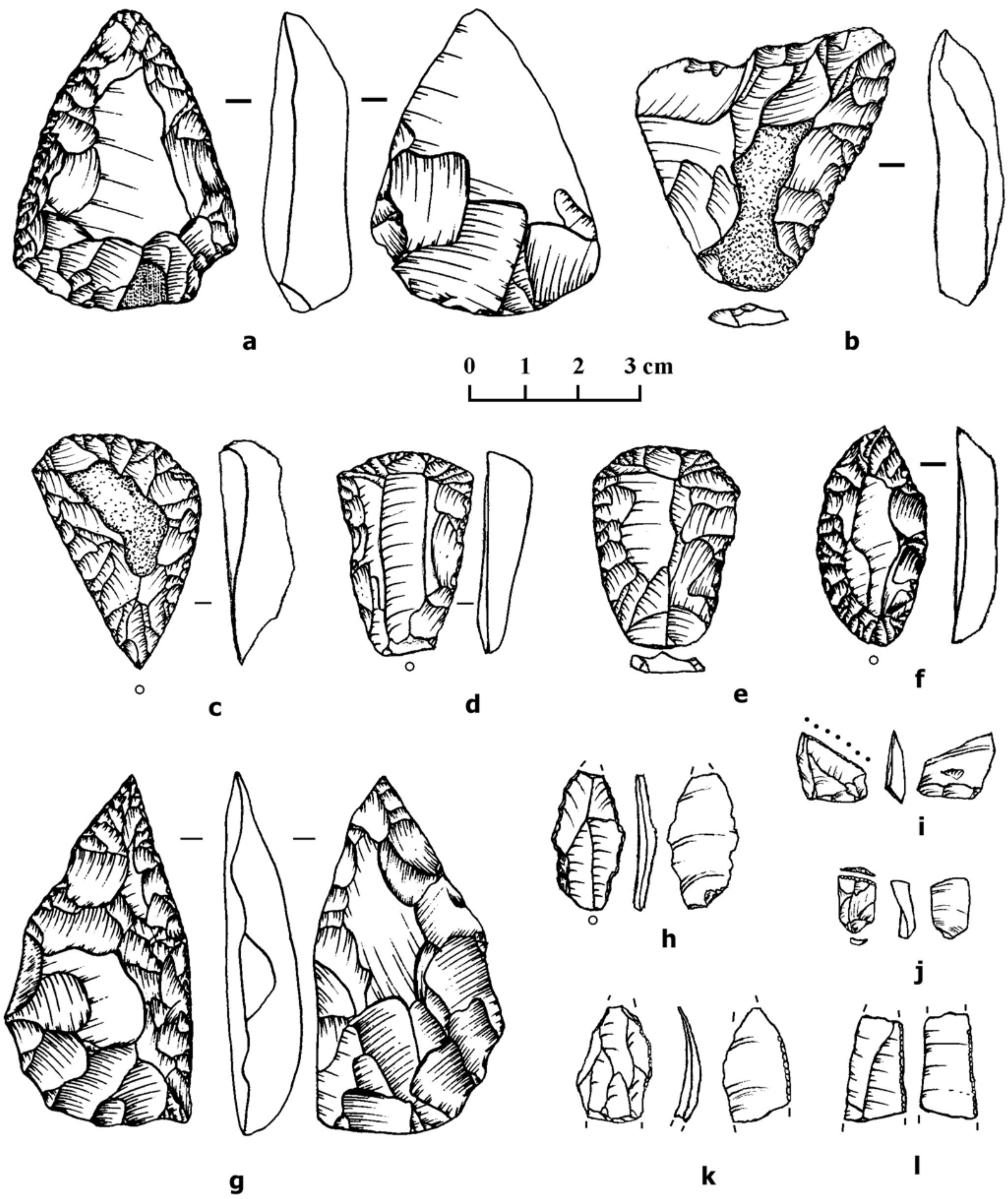


FIGURE 11 (Mira) – Materials from cultural layer I: a. Mousterian-type point with ventral thinned base; b. Double canted side scraper; c. Mousterian-type point-endscraper on flake; d and e. Bilateral retouched end scrapers on blades and blade flakes; f. Double convergent side scraper (limace); g. Plano-convex bifacial point with back or backed knife; h. Krems-Dufour point; i. Non geometrical microliths of Mira-type on waste flake of resharpening of bifacial tool; j. Non geometrical microliths of Mira-type on waste flake of resharpening of flake tool; k and l. Dufour bladelets.

8 CHRONOSTRATIGRAPHIC BACKGROUND (P.H. & N.G.)

The chronostratigraphic approach of the Mira succession rests mainly on two sets of data. On the one hand, three sedimentary bodies belong to the lower Dnieper terrace (units IV and III, subunits IIC and IIB), grading into sub-aerial cover deposits (subunits IIA and IB pro parte) which are capped by the Holocene pedocomplex (subunits IB pro parte and IA). On the other hand, the fine grained alluvial deposits of unit III are preserved in between the fluviatile sandy bodies which contains the Palaeolithic cultural layers I and II/2. Moreover, unit III records a fairly homogenous episode of sedimentation close to the main channel of the Dnieper, under a cool and steppic environment. It corresponds to a rather short period of time, radiocarbon dated in between ca 28,000 and 26,000 BP, almost at the end of the Middle Pleniglacial and prior to the cooling recorded by the restart of the sandy fluviatile sedimentation (subunit IIC).

Taking into account the geographic situation of Mira in Central Ukraine, only a limited number of well documented stratigraphic loess successions could be used as a reference for comparisons. It is the case of the East Carpathian Area with the Palaeolithic sites Molodova V (Western Ukraine), Mitoc-Malu Galben (Romania) and Cosautsi (Republic of Moldova). The combined stratigraphies of these sites provide a well dated high-resolution pedosedimentary and climatic sequence (**figure 12**) covering the whole period between ca 33 ka BP and the Holocene (Haesaerts 2004; Haesaerts *et al.* 2003). In particular, the most complete pedosedimentary sequence for the transition from Middle to Late Pleniglacial is recorded at Mitoc-Malu Galben, with a succession of four distinct interstadial humic horizons of decreasing intensity: respectively MG 11 (around 30 500 BP), MG 10 (around 28 600 BP) MG 9 (around 27 800 BP) and MG 8 (close to 27 000 BP). This succession is capped by a well developed tundra gley related to a drastic cooling precisely dated between 26 300 and 25 760 BP, which ends the Middle Pleniglacial (Haesaerts *et al.* 2007; 2010).

Considering the East Carpathian sequence, unit III at Mira fits in with the final part of the Middle Pleniglacial, the humic horizons containing cultural layers II/2 and I which are ascribed to the interstadial events MG 9 and MG 8 (**figures 12** and **13**). In this way, the cryoturbated gley horizon of layer 22 capping unit III may be related to the toundra gley dated around 26 000 BP at Mitoc-Malu Galben. With regard to this scheme, the upper fluviatile record at Mira (subunits IIC and IIB), as well as the cover deposits of subunit IB, could be ascribed to the first half of the Late Pleniglacial, with a possible connection between the hydromorphic alluvial soil of layers 18 and 17 and the well developed tundra gley dated around 23 000 BP in the East Carpathian Area. In a similar way, the upper sandy loam cover at Mira (subunit IIC and subunit IB) belongs probably to the second part of the Late Pleniglacial recorded for the best at Cosautsi along the Dnieper (Haesaerts *et al.* 2003).

The banded Bt horizon of the forest soil developed from the top of subunit IB (layers 9 and 8) is ascribed to the Early Holocene, a period characterised by rather humid climate, favouring forest distribution, in the steppe zone of Ukraine (Gerasimenko 1995, 1997). Moreover, the sandy layer 7 at the base of subunit IA, above the forest soil, reflects an episode of dry conditions with an intense wind activity known in the steppe zone around 8 and 4 ka BP. (Gerasimenko 1995, 1997), whereas the climatic optimum of broad-leaved forest distribution occurred around 5.5 ka BP (Hotinsky 1982). The "borovoy chernozem" of layers 6 and 5 containing Bronze Age implements dated around the 14^{th} and 13^{th} centuries BC, most probably records the wet interval of the Subboreal (Gerasimenko

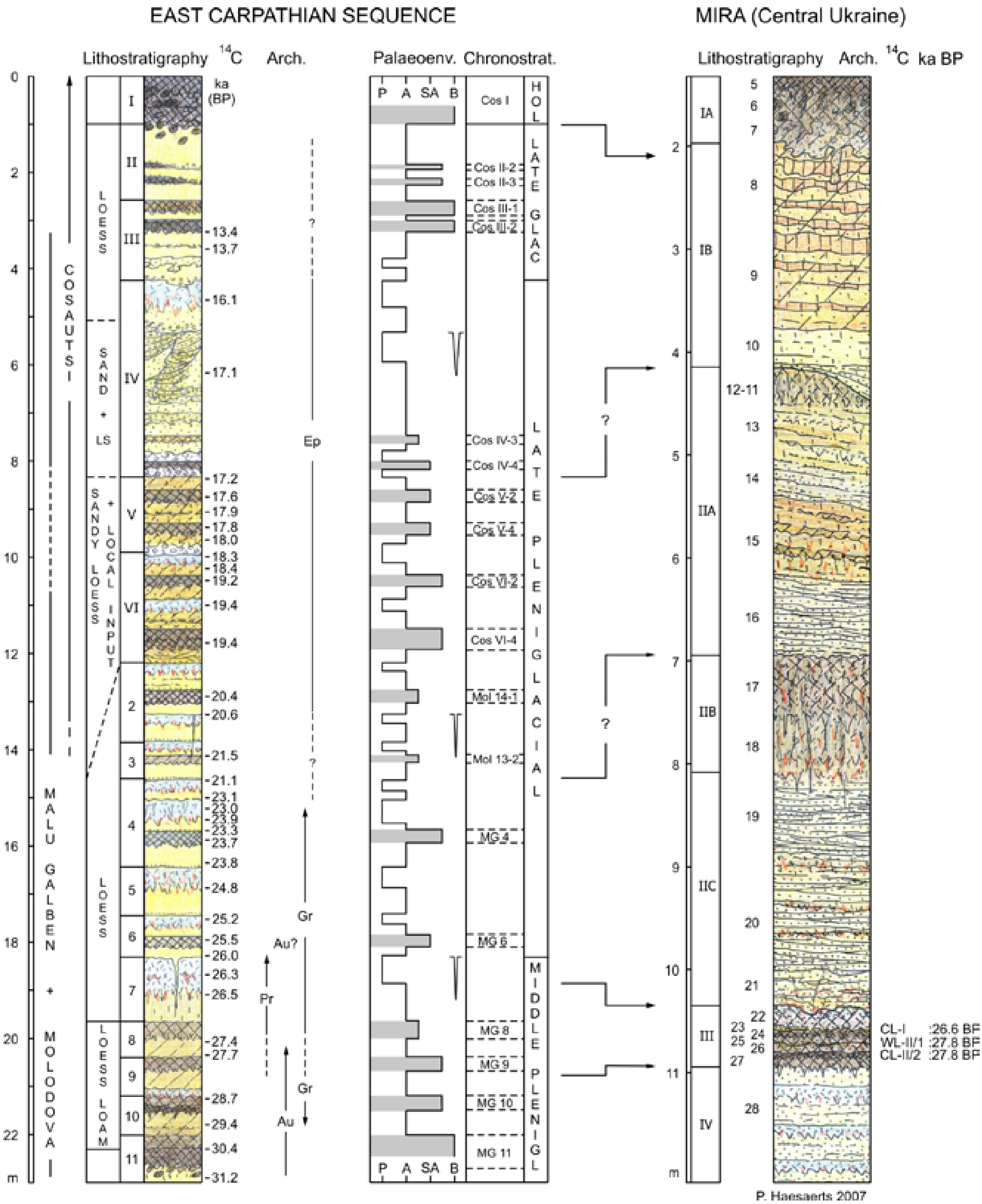


FIGURE 12 (Mira) – Correlative scheme with the East Carpathian Area (Haesaerts et al. 2003, 2010). Graphic symbols as in figure 10. Abbreviations: (Arch) Archaeology; (Au) Aurignacian; (Gr) Gravettian; (Ep) Erigravettian; (Palaeoenv) Palaeoenvironment; (P) Permafrost conditions or deep frost; (A) Arctic; (SA) Subarctic; (B) Boreal; (Chr) Chronostrat-interstadials; (Cos) Cosautsi; (Mol) Molodova; (MG) Malu Galben.

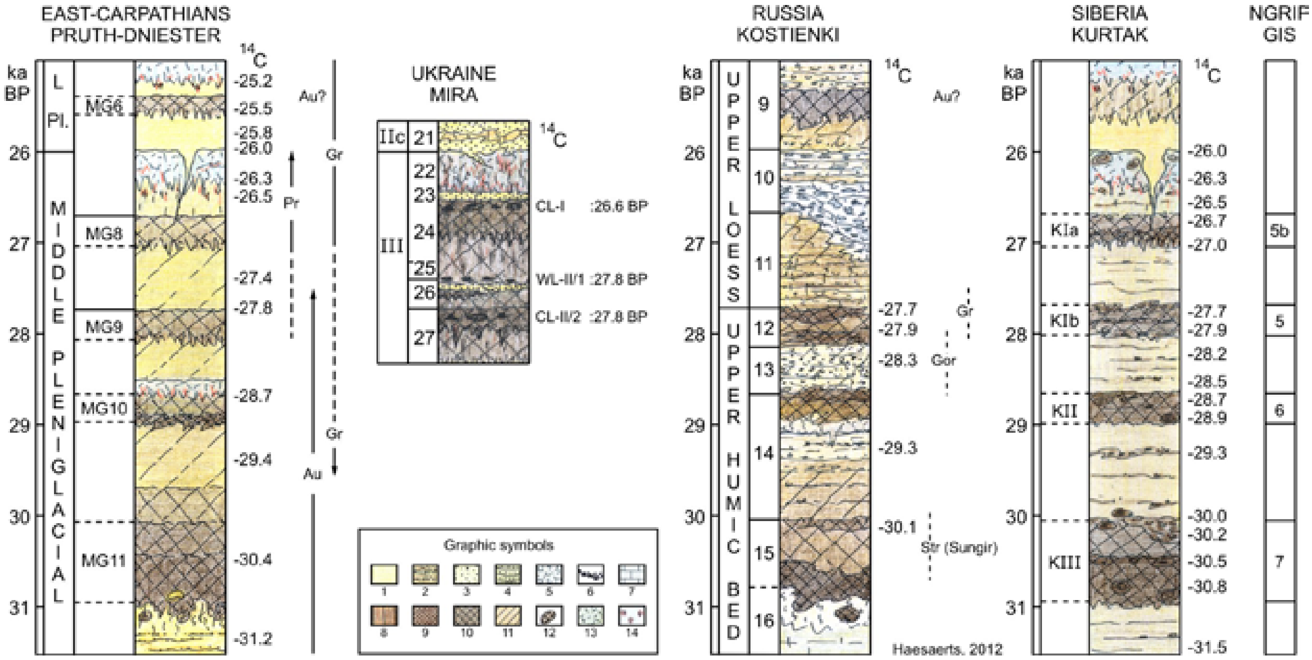


FIGURE 13 Overview of the correlation scheme linking Mira unit III sequence with the surrounding loess areas. The Siberian sequence of Kurtak (Haesaerts *et al.* 2005) is used as reference for proxy-correlation with GIS of NGRIP (Haesaerts *et al.* 2009). Graphic symbols: 1. Loess; 2. Loan; 3. Silty sand; 4. Sand; 5. Chalky flow; 6. Gravel; 7. Limestone; 8. Illuviated soil; 9. Strong humic horizon; 10. Weak humic horizon; 11. Yellowish brown bioturbated horizon; 12. Krotovinas: 13. Bleached horizon (tundra gley); 14. Iron staining. Abbreviations; Arch: archaeology; Gr: Gravettian; Pr: Pruth Culture; Au: Aurignacian; Gor: Gorodsovian: Str; Streletskian.

1997). In a similar way, the second chernozem-like soil (layer 3) with ceramics dated to 5–4 centuries BC is related to the Early Subatlantic also known as a humid period (Hotinsky 1982). Within this system, the dry period corresponding to sandy layer 4 could be related to the 9^{th}–7^{th} centuries BC, while sandy layer 2 which wears the surface humiferous horizon (layer 1), shows the last Subatlantic aeolian input of the Holocene sequence.

9 ARCHAEOLOGICAL BACKGROUND (P.H. & V.S.)

Geological, paleontological and radiocarbon chronology data unanimously demonstrate two successive Palaeolithic occupations at Mira during rather cool interstadial episodes characterised by meadow communities in the bottom valley. This episode was radiocarbon dated between ca 28,000 and ± 26,500 BP at the end of the Middle Pleniglacial. Palaeolithic man settled twice in the alluvial plain of the Dnieper probably close to the fluviatile channel. Each archaeological layer was buried by fine grained alluvia quickly after the occupation, a situation leading to good preservation of the remains of human activities.

Taphonomic characteristics and richness of cultural remains make Mira an ideal case study. The site provides clear instance of superposition of technologically and typologically more advanced layer II/2 industry of definitely Upper Palaeolithic appearance by more archaic layer I industry comprised both Middle and Upper Palaeolithic features and associated with anatomically modern humans. Mira cultural layer I assemblage yields fusion of traits of Crimean Middle Palaeolithic Micoquian (Kolosov *et al.* 1993), of Upper Palaeolithic Aurignacian and of Eastern early Upper Palaeolithic of River Don Area (Sinitsyn 1996, 2000).

Fusion of Middle and Upper Palaeolithic features in materials of Mira cultural layer I allows to regard it as directly related to the problem of Middle to Upper Palaeolithic transition in the territory of Eastern Europe. Cultural Layer I industry cannot be estimated as belonging to a genuine initial Upper Palaeolithic in understanding of the earliest appearance of new technologies and behaviour strategies, though there are grounds to consider it as transitional one.

Nevertheless, occurring midway between the East Carpathian Area and the Don, the distribution of the Mira cultural assemblages appears to be somehow consistent with the archaeological background of the final part of the Middle Pleniglacial at the scale of the East-European loess domain (**figure 13**). On one side, in the Dniester and Prut basins Aurignacian is well documented up to ca 27 700 BP, the full development of the classic Gravettian starting around 27 000 BP, some Early Gravettian occurrences being dated 29 350 BP at Molodova V (CL 10 and 9, *cf.* Haesaerts *et al.* 2003, 2010). Still, in this region Aurignacian and Gravettian are co-existing with some cultural assemblages containing bifacial tool-kit, reported to the "Pruth Culture" dated between 28 000 and 26 000 BP (Noiret 2009). On the other side, to the East of Moscow Streletskian is presently dated 30 100 BP at Sungir (Marom *et al.* 2012), whilst at Kostienki 14 the Gorodsovian is reported around 28,300 BP (Sinitsyn, 1996; Haesaerts *et al.*, 2004; Velichko *et al.* 2009), prior to the first Gravettian occupation dated 27 700 BP at Kostienki 8 (Praslov & Rogachev 1982). Finally, on both sides of the Russian Plain Late Aurignacian is recorded around 25 000 BP at the onset of the Late Pleniglacial, respectively at Climautsi along the Dniester (Chirica *et al.* 1996; Noiret 2009) and at Kostienki 1 as part of cultural layer III (Damblon *et al.* 1996; Sinitsyn 1996; Sinitsyn & Hoffecker 2006).

ACKNOWLEDGEMENTS

Full-scale excavation at the site of Mira in 2000 was funded by L.S.B. Leakey foundation. Large and middle-sized fauna was studied by Dr. O. Zhuravlev (Institute of Archaeology of NASU, Kiev, Ukraine) and Dr. P. Putshkov (Schmalgausen Institute of Zoology of NASU, Kiev, Ukraine). Microtheriofauna was examined by Prof. L. Rekovets (National Natural Science Museum, Kiev, Ukraine). Petrographical study was conducted by Dr V. Petrougne (Odessa, Ukraine). Anthropological find was studied by Prof. C. Turner (Arizona State University, Tempe, USA). This work is also a contribution of the Sc–09 and MO/36/021 research projects of the Belgian Science Policy, with complementary funding from the INTAS 2000–879 Project. The authors thanks Eric Dermience for its technical assistance in producing the infographic work.

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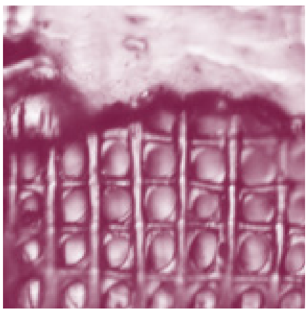

Stratigraphic succesion