Research Article

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Chipped Stone Assemblage of the Layer B of the Kamyana Mohyla 1 Site (South-Eastern Ukraine) and the Issue of Kukrek in the North Meotic Steppe Region

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Abstract: The layer B is one of the lower layers of the long stratigraphic sequence of the Kamyana Mohyla 1 site. The layer B received eight new AMS radiocarbon dates that clarified its chronology: 7950–7300 calibrated years BC. They are in a reasonable correspondence with the dates for lower and upper layers. The lithic assemblage belongs to Kukrek cultural aspect. It is characterized by pencil-like conical cores, Kukrek inserts, Kukrek burins and Dęby burins, nongeometric microliths (oblique points). The assemblage finds close parallels in the sites of Kukrek, Ihren VIII, Melnychna Krucha SU4 and Domchi-Kaia. They can be united into Kukrek *sensu stricto* cultural unit. The overlying layer C yielded somewhat different complex that finds parallels in the materials of the so-called "Kukrek cultural tradition." Due to clear stratigraphic position of these units in the Kamyana Mohyla 1 sequence, we are able to differentiate Kukrek *sensu stricto* and "Kukrek cultural tradition" and suggest their respective chronological positions.

Keywords: Middle Mesolithic, Pontic Steppe, lithic technology, Kukrek inserts, Kukrek burins

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1 Introduction

In the steppe belt of North Pontic region, Mesolithic sites are mostly attributed to one of two cultural aspects: Hrebenyky (Grebeniki) and Kukrek (Kozlowski & Kozlowski, 1979; Stanko, 1967; Telegin, 1982). While the former is analogous to the Late Mesolithic complexes of the Balkans (*Tardenoisian pontique*, Boroneanţ, 2005; Gatsov, 1989; Păunescu, 1979) and the southern Europe (Castelnovian, Perrin & Defranould, 2016), the latter finds no direct parallels in the archaeological record of western or southern Europe. Kukrek is a technocomplex defined by presence of bone and antler "spear-/dart-heads" (Figure 1), probably also armed with backed bladelets and backed and truncated flint points (Telegin, 1982). Contrary to the common practice, the definition of the Kukrek technocomplex is based upon functional tools (*l'outillage du fonds commun*, G.E.E.M., 1975) not types of microlithic projectiles. When defined in such a way, this cultural aspect seems to last since the early Holocene up to the middle Neolithic. The Kukrek sites are also widely distributed encompassing various environmental zones. Nowadays, it is seen in Ukrainian archaeology as a "super-culture" spanning from the Epigravettian well into the developed Neolithic (Zaliznyak, 2005). Numerous buzzwords (like Kukrekoid etc., for a detailed account, see below) entered the literature indicating a general ambiguity of the term. There are reasonable grounds to doubt this interpretation. One of them is a lack of well-established chronologies for any site of this cultural aspect.

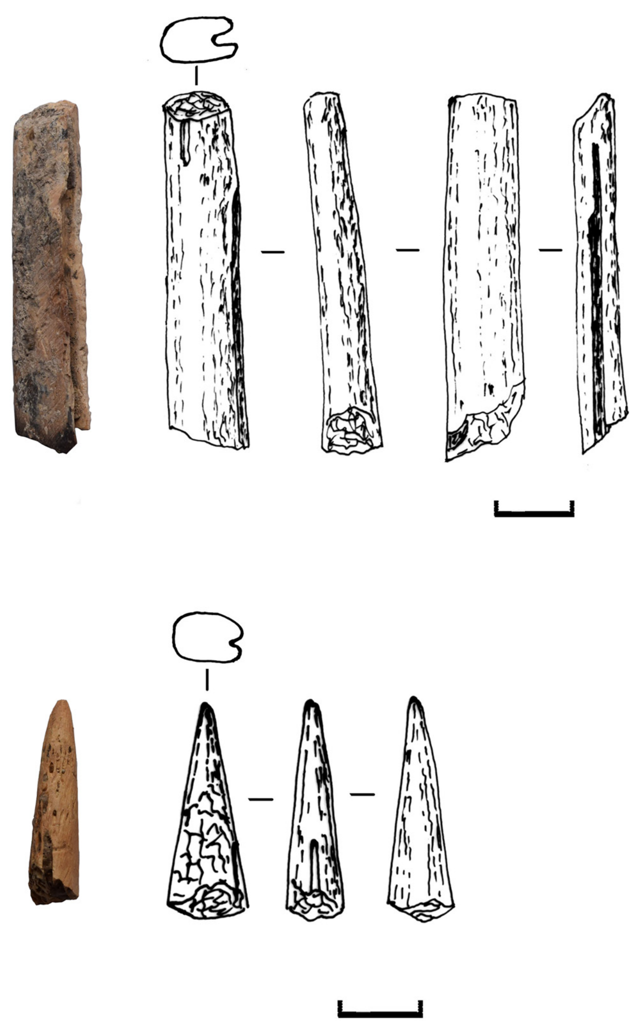

Figure 1: Bone points from the layer B of Kamyana Mohyla 1. Above – 2018, trench 2, sq. 16, z – 90; Below – 2017, trench 2, sq. 17, z – 92.

There is an evident need for “regionalization” and “temporal localization” of the Kukrek phenomenon (Kiosak, 2019). The authors of this article believe that the redefinition of the Kukrek concept is an urgent issue to be solved for a better understanding of the Mesolithic background of Neolithization in the south of Eastern Europe (Kotova, 2003).

This issue can be exemplified by a reference to a typical Kukrek site of the Azov Sea region (Meotic region) – Kamyana Mohyla 1 (Figure 2). According to V. M. Danilenko, it is a stratified site with over 12 layers of various cultural aspects from the Mesolithic till the Iron Age (Danilenko, 1969, 1974, 1986). Telegin (1990) believed that the site of Kamyana Mohyla 1 was settled at least six times; however, the Mesolithic and Neolithic habitations were described in a very different (from V. Danilenko’s) manner (Telegin, 1990). The problem of these discrepancies is still unsolved (Kotova et al., 2017; Kotova, 2003). Here, we describe a layer situated immediately below the lowest potsherds ever found on the Kamyana Mohyla 1 (KM1) site. It was denominated “layer B.” As one can see from the description of stratigraphy, this label is fully conventional and is chosen exclusively in order to avoid a preliminary and hasty naming of the layer by a hypothetical cultural attribution.

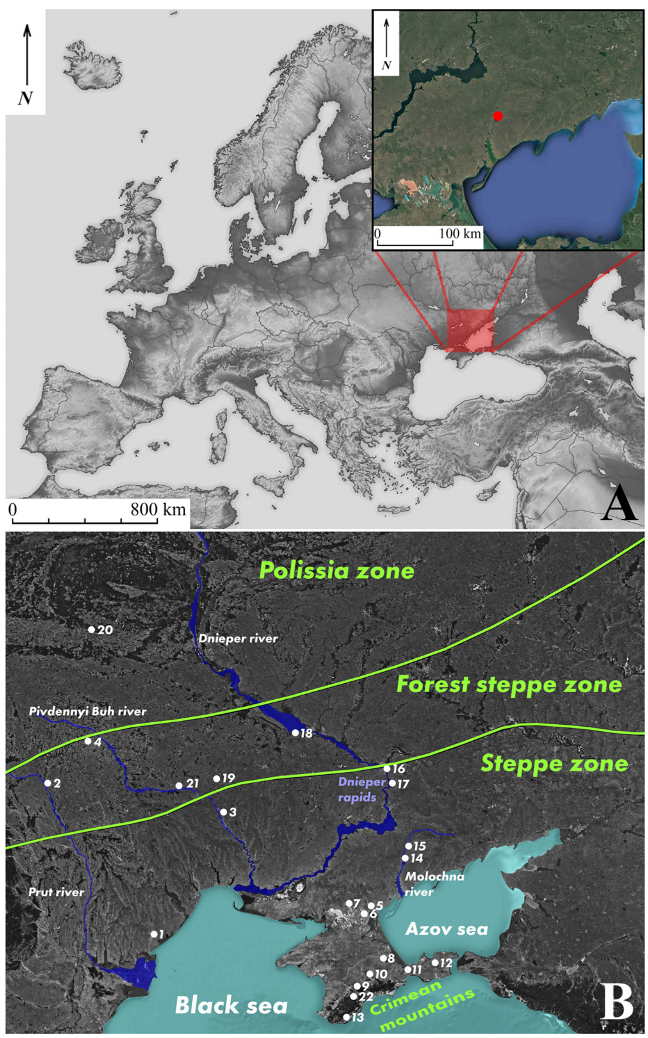

Figure 2: (a) Map: Situation of North Meotic region in Europe (rectangle) with a location of the Kamyana Mohyla 1 site (red circle) (b) Map: Sites in the south of Eastern Europe which were attributed to “Kukrek” *sensu lato*: (1) Trapivka, (2) Badragii Vechi, (3) Abuzova Balka, (4) Mykolaivka, (5) Liublinka II, (6) Vesnianka V, (7) Serhiivka I, (8) Olexiivska Zasukha, (9) Kukrek, (10). Vyshenne 1, (11) Frontove, (12) Tasunove, (13) Balin-Kosh, (14) Kamyana Mohyla 1, (15) Prylukivka, (16) Ihren VIII, (17) Sursky ostriv, (18) Velyka Andrusivka, (19) Dobrianka III, (20) Lazorivka, (21) Melnychna Krucha, (22) Domchi-Kaia.

2 Situation and Geological Background

The open-air stratified site of Kamyana Mohyla I was discovered by V. M. Danilenko in the 1930s. It is situated in front of a natural sandstone mound (Kamyana Mohyla, Stone Mound, Figure 3a), where numerous examples of rock art have been recovered (Gladilin, 1966–1969; Mykhailov, 2005; Rudynskyi, 1961).

The site is situated on the flood plain of Molochna River, more precisely, on the triangular promontory of the shore of an old riverbed called Sekiz (Figure 3(a)). It is a flat surface some 3 m high over the modern water stand in the Molochna River. It gets somewhat higher closer to the high terrace. Thus, it is a young, highly eroded terrace-like elevation made up of loams moved down by slope processes and alluvial sediments brought here by the river, which explains the relatively fast sedimentation. The latter resulted in a quick burial of cultural remains and formation of a complex "long sequence." Mesolithic and Neolithic layers are some 2 m thick, when taken together. The layers are relatively well preserved. The Mesolithic stratigraphic units contain horizontal scatters of bones, shell middens, scatters of chipped stone debris, fireplaces and pits. Thus, the site is situated on the high meadow plain terrace in the process of formation.

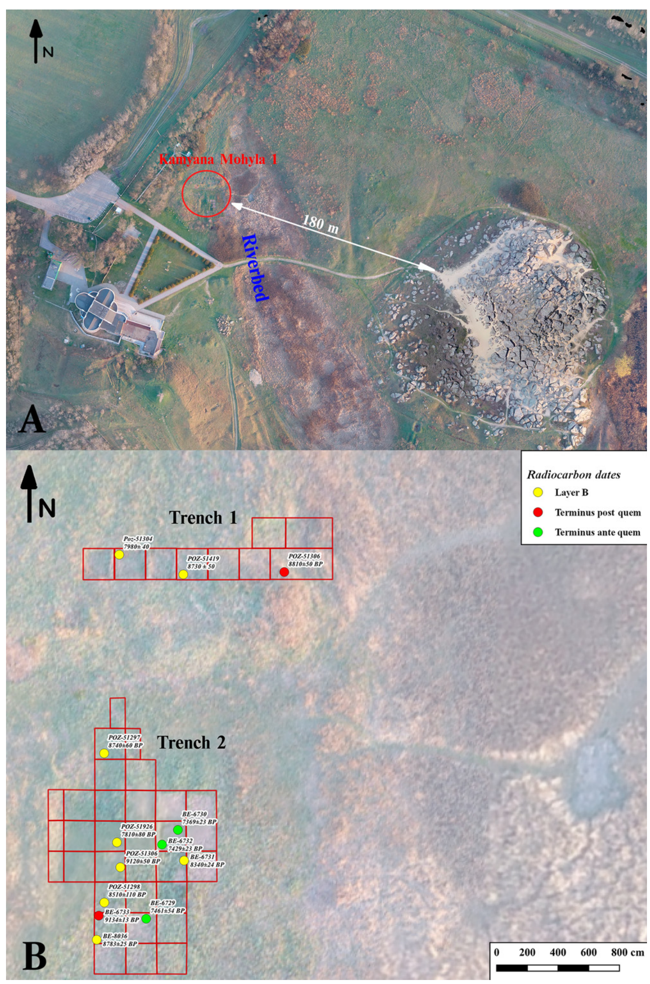

Figure 3: (a) Situational plan of the Kamyana Mohyla 1 site (red circle); (b) Location of excavation trenches on the site of Kamyana Mohyla 1 with indication of sampling for radiocarbon dating.

3 History of Research on the Mesolithic Complexes of Kamyana Mohyla I

For the first time the Kamyana Mohyla site was excavated by O. N. Bader. He published a list of finds coming from "underlying (under layer with Neolithic pottery — D. K.) horizons of light-coloured loam with rests of six or seven fireplaces" (Bader, 1950). This list includes an elongated trapeze, end-scrapers on blades, multiple burins of various types, mostly done on blades, narrow, fine, parallel-sided "knife-like" bladelets. Noteworthy, a bone point was found with narrow bladelets inserted in a groove. O. N. Bader attributed the layer to "Tardenoisian with some elements of Azilian." The figure also represents subcircular and semi-circular scrapers on flakes, scraper-like tool, retouched blades. The burin on a "core-like fragment" could in fact be a "Kukrek burin" in modern terminology. This fact, alongside with a variety of burins on blades and mainly a grooved bone point, gives us some reasons to correlate the layer described by O. N. Bader with the layers B and C of recent works on the site.

After the excavation in 1947, V. M. Danilenko was able to define an "Archaic Neolithic" horizon characterized by lithics of "Tardenoisian aspect" or "Epi-Tardenoisian character" (Danilenko, 1952, p. 68). Later, the chipped stone assemblage of the upper Archaic Neolithic layer was described as an "apex of the microlithic technique development" and "quasi-complete repetition of Kukrek industry sites." The finds comprise pencil-like cores, multiple microblades, fine "cutters" (see further for an explanation of the term) and small end-scrapers. Geometric microliths were "almost" absent (Danilenko, 1969, p. 10). The most detailed description of the Kamyana Mohyla 1 lithic assemblage was published in 1986 (Danilenko, 1986, pp. 24–27). Unfortunately, the description is almost completely devoid of numerical characteristics and is fully denominative.

D. Ja. Telegin published V. M. Danilenko's collection (Telegin, 1982) and his own collection gathered in excavations of 1983 and 1987 (Telegin, 1990, 2002). He was the first to define the layer under the most ancient pottery as a Mesolithic layer and include it in his Kukrek cultural entity as a representative of its Crimean-North Azov variant (Telegin, 1982, pp. 101–104). D. Ja. Telegin has never published a quantitative composition of the old collection. The typological composition of his own collection (over 150 items) was briefly summed up (Telegin, 2002, pp. 61–62). The collection of V. M. Danilenko (some 500 items) was most likely analysed and counted by Telegin, but these data remained unpublished, probably due to his ethical obligations in front of V. M. Danilenko's memory (deceased in 1982). The "old" collections were gathered by "conventional cuts." Taking into account a complex stratigraphy of the Mesolithic sequence at the Kamyana Mohyla 1 site, it makes impossible the direct numerical comparison between any of "old" collections and recently obtained materials.

In 2011, the excavation on Kamyana Mohyla 1 was resumed by a joint Swiss-Ukrainian project (under the lead of N. Kotova and W. Tinner, Kotova et al., 2017). The works lasted from 2011 till 2018 (with a break in 2014–2015). The excavations were carried out with a microstratigraphic approach, mapping every find in three dimensions. Sediments were studied by paleopaedologists and pollen analysts. The preliminary results on the site's stratigraphy were published in a collective monograph (Kotova et al., 2017).

Thus, the reference site of the Kukrek cultural aspect (Kamyana Mohyla 1) has no numerical typological description of lithic finds despite the 70-year-long history of research. This situation hampers our interpretation of the Mesolithic in the south of Eastern Europe.

4 Stratigraphic Position of the Layer B

The surface of the site was partially damaged by removal of upper soil horizons with an aid of heavy building technique in early 1970s. So, excavation trench № 1 was opened on the intact portion of the site, while excavation trench № 2 was placed on the damaged area (Figure 3(b)). Excavation trench № 2 yielded a much larger quantity of artefacts. The layer B was found in both excavation pits at a certain depth (Figure 4). Thus, it was not disturbed by the heavy technique operating much higher.

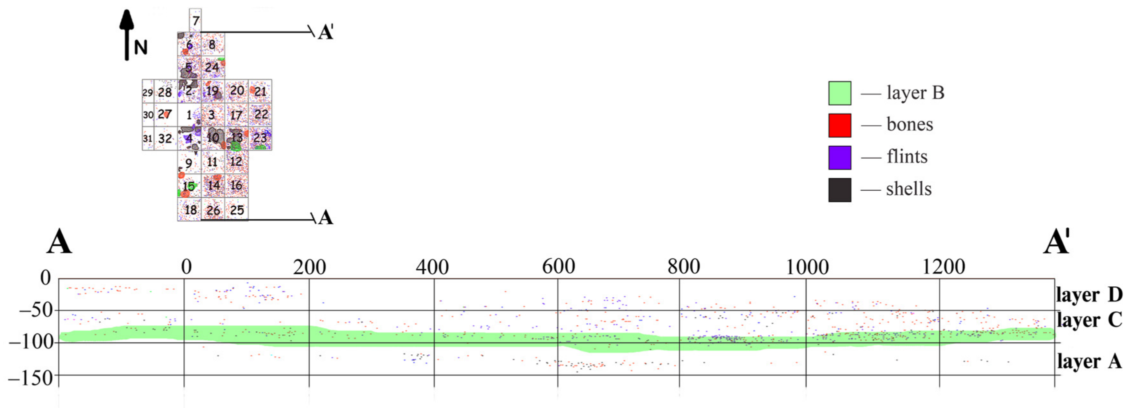

Figure 4: Profile across 3D cloud of points from excavation trench 2 with indication of the layer B (in green).

By now, the layer B was opened on the area of 120 sq. m in trench 2 (Figure 4) and 36 sq. m in trench 1. We studied the collection gathered in the excavations of 2011–2013. Six hundred and five chipped stone finds come from the layer B of trench 2, and 13 such items come from the layer B of trench 1. The density is either 13.75 (trench 2) or 3.25 (trench 1) finds per square meter. Thus, the trench 2 was more saturated and is probably situated close to the centre of the site, while trench 1 recovered a site's periphery.

The small collection from trench 1 was already published (Kotova et al., 2017). So, here we focus our attention on the representative assemblage of trench 2.

The layer B contained several scatters of lithic artefacts, at least two fireplaces and shell middens at variable depth (Figure 5). Some scatters laid "carpet-like," being as thick as a single find. Maybe, these scatters correspond to discrete episodes of human habitation on the site and can be defined as separate subhorizons of the layer B, later, when the excavated surface will be enlarged. The layer is well preserved. It

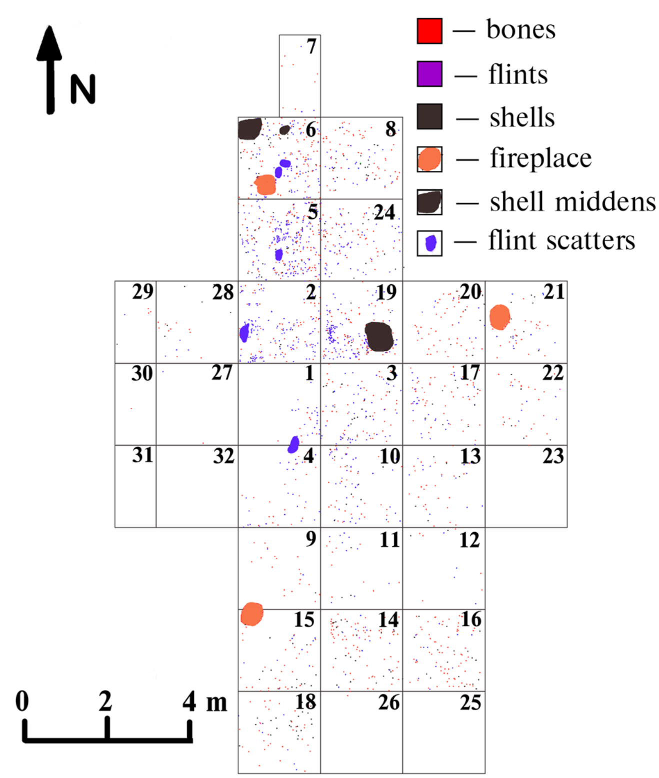

Figure 5: Plan of the layer B in excavation trench 2.

yielded multiple organic finds (animal bones and shells). Most chipped stone artefacts are not patinated or damaged in any other way. There are several cases of lithic artefacts' refitting in the collection.

The "lens" of layer B is well-visible on the 3D point cloud of the site (Figure 4). It is separated from archaeological deposits above by a non-sterile but obviously less saturated layer, some 10–15 cm thick. It is parted from lower horizons by a sterile layer that is some 20 cm thick. The layer B is characterized by an enlarged number of shells compared to the sediments above.

5 Chronology of Layer B

There were several efforts of radiocarbon dating of the Kamyana Mohyla 1 site. The earlier attempts were based on conventional dates obtained in the Kyiv radiocarbon facility (Kotova, 2003; Telegin, 1990) prior to 2011 (resumption of the field work on the site). They highlighted the complex stratigraphy of the site. The materials of the recent excavations were dated by the AMS method in Poznan laboratory and in the facility LARA of Bern University (Figure 6).

The layer A of Kamyana Mohyla 1, which underlies the layer B, yielded several fireplaces, shell middens and pits. It existed in 8420–7750 calBC (2σ) according to non-modelled dates and in 8420–7910 calBC (2σ), when we use Bayesian modelling (Figure 7). Its lithic assemblage is characterized by impoverished typology with low percentages of formal tools (Kotova et al., 2017). The results of radiocarbon dating here and further have been calibrated with OxCal 4.4.2 (Ramsey, 2009) using atmospheric data from Reimer et al. (2020).

The layer C of Kamyana Mohyla 1 (above the layer B) is characterized by a "striped" distribution of artefacts. Actually, the concept of layer C includes several lenses of artefacts, bones and shells spread in-between rich series of the layer D (containing numerous para-Neolithic potsherds) and the layer B. The lowest and the most ancient potsherds (of the Sursky culture style) were found on the depths comparable

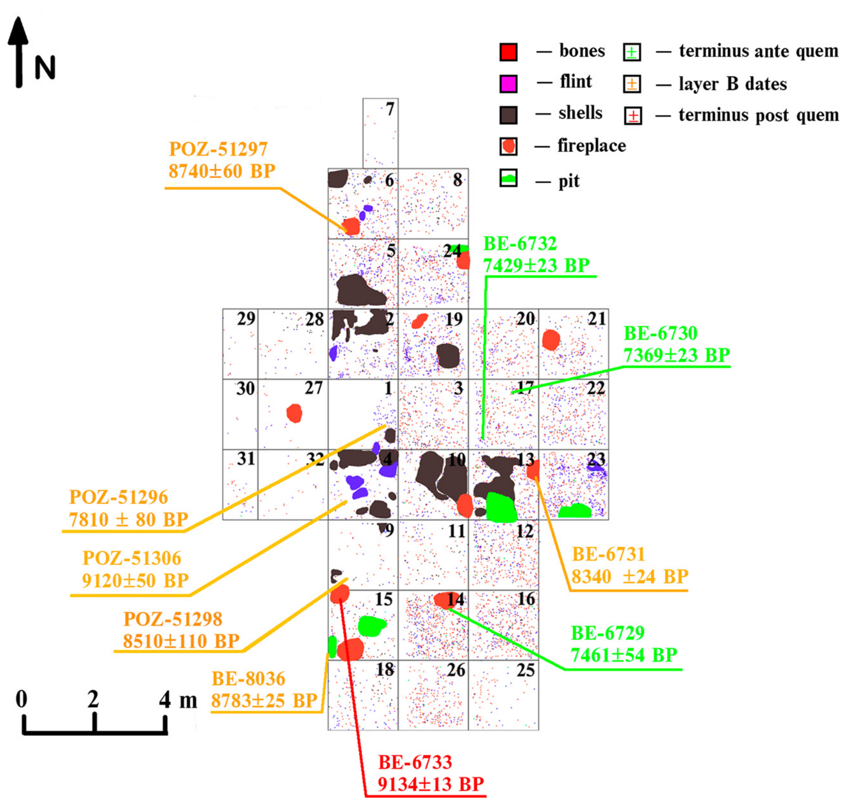

Figure 6: Plan of excavation trench 2 with indication of samples for radiocarbon dating.

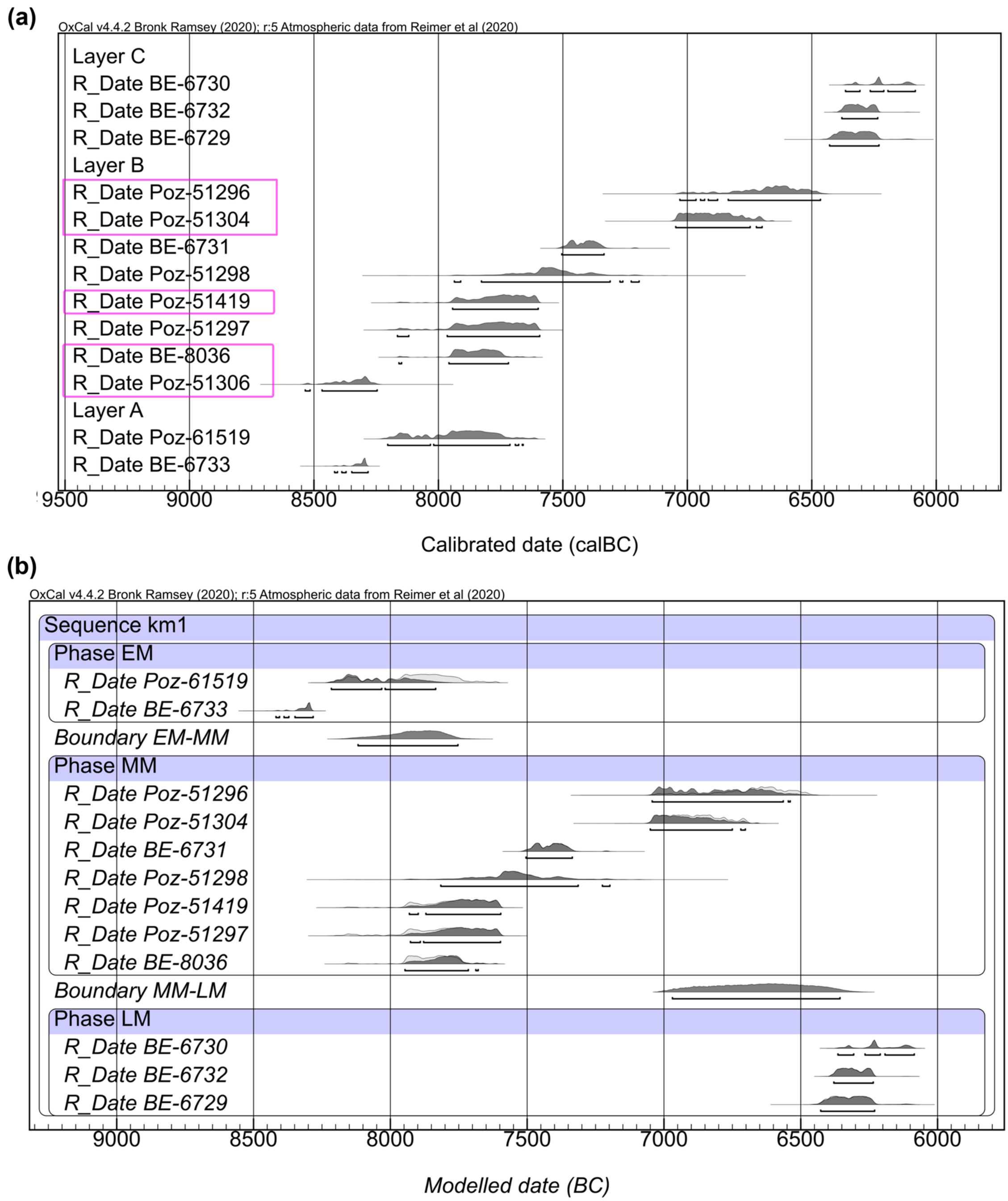

Figure 7: (a) Calibration of AMS dates for the Kamyana Mohyla 1 site (in the order of appearance). Dates on animal bones are in purple rectangles. Other dates are on charcoal. (b) Modelled calibration of AMS dates for the Kamyana Mohyla 1 site. EM – Early Mesolithic (layer A), MM – Middle Mesolithic (layer B), LM – Late Mesolithic (layer C).

with the depth of layer C in certain parts of the excavation area (Kotova et al., 2017). A similar observation was made in the earlier excavations (Kotova, 2003; Telegin, 1990).

Some of the lenses of layer C were dated by radiocarbon method. Namely, the hearth in sq. 14 from depth of 48–60 cm obtained a ^{14}C date of 6430–6230 calBC (2σ), and the charcoal scatter in sq. 17 (76 cm deep) obtained two similar dates, encompassing 6380–6084 calBC (2σ). Comparable dates were obtained during previous efforts to date the site with an application of conventional radiocarbon analysis (Figure 8(a), Table 1), namely the dates Ki-7667, Ki-4226, Ki-4022, calibrated to 6370–5791 calBC (2σ).

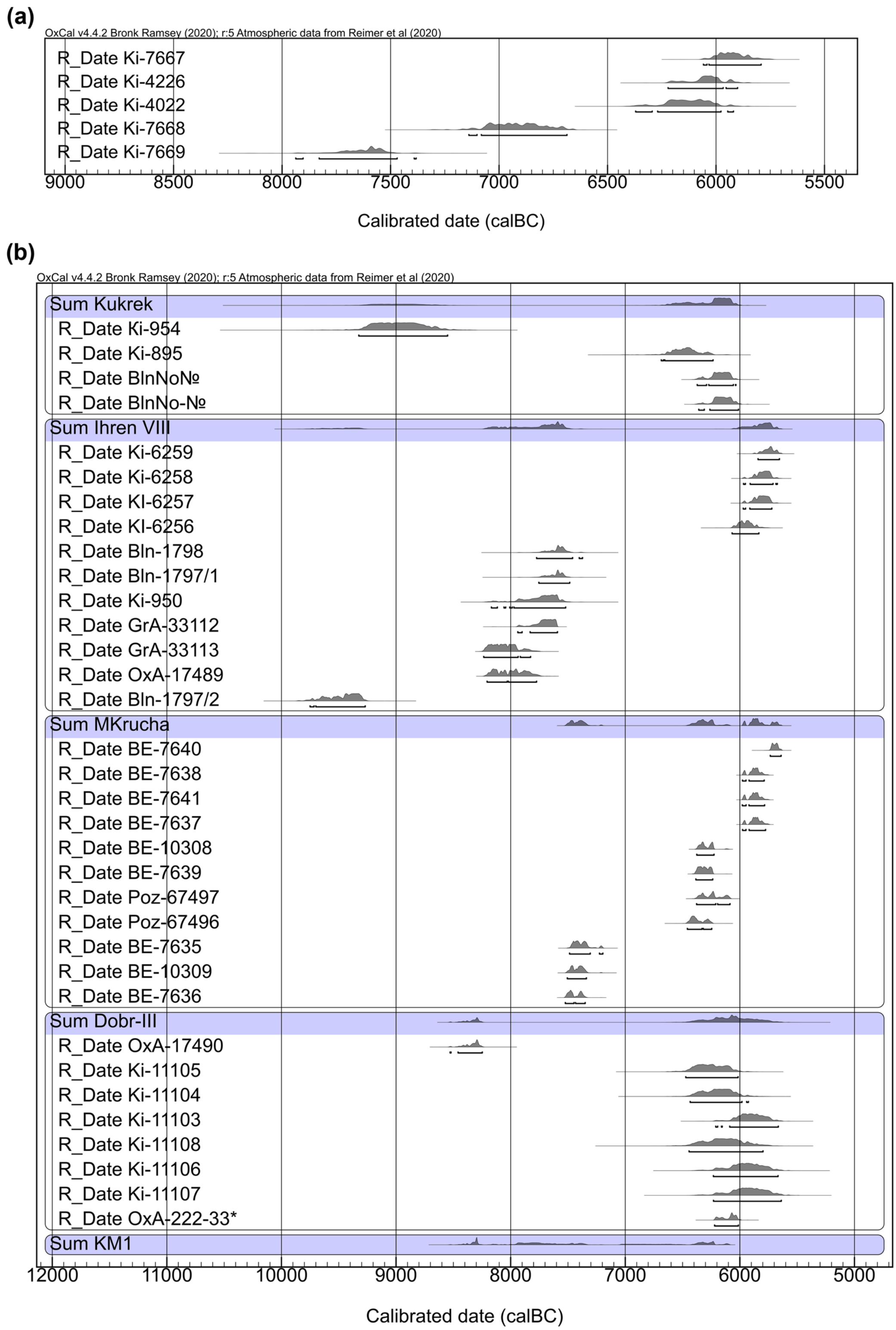

Figure 8: (a) Conventional dates for the Kamyana Mohyla 1 site (after Kotova, 2003; Telegin, 1990); (b) Sum of dates for Mesolithic layers of the Kamyana Mohyla 1 (KM1) site and relevant dates of Kukrek sites (after Kiosak et al., 2021; Kotova, 2003; Lillie et al., 2009; Telegin, 2002; Zaliznyak et al., 2013) from North Pontic region. Dobr-III – Dobrianka III, MKrucha – Melnychna Krucha.

Table 1: Relevant radiocarbon dates for the Kamyana Mohyla 1 site

Provenance	Lab. number	Date BP	SD	Material	CalBC (1 s)	CalBC (2 s)	Reference
Tr. 2 – sq. 17, depth 50–63 cm, fireplace, layer C	BE-6730	7369	23	Charcoal	6333–6094	6364–6083	This work
Tr. 2 – sq. 17, depth 76 cm, fireplace, layer C	BE-6732	7429	23	Charcoal	6367–6242	6378–6234	This work
Tr. 2 – sq. 14, depth 48–60 cm, fireplace, layer C	BE-6729	7461	54	Charcoal	6392–6251	6248–6229	This work
Tr. 2 – sq. 1, depth 91–93 cm, layer B	Poz-51296	7810	80	Animal bone	6767–6502	7029–6464	This work
Tr. I – sq. 5, Depth 140 cm, layer B	Poz-51304	7980	40	Animal bone	7036–6825	7046–6699	Kotova et al., 2017
Tr. 2 – sq. 13, depth 73 cm, charcoal scatter, layer B	BE-6731	8340	24	Charcoal	7478–7356	7504–7334	This work
Tr. 2 – sq. 9, layer B	Poz-51298	8510	110	Charcoal	7705–7370	7935–7193	This work
Tr. I – sq. 3, 140 cm, layer B	Poz-51419	8730	50	Bone of a large ungulate	7815–7605	7942–7598	Kotova et al., 2017
Tr. 2 – sq. 6, depth 85–94 cm, fireplace, layer B	Poz-51297	8740	60	Charcoal	7936–7606	8164–7592	This work
Tr. 2 – sq. 15, Pit 1, depth 79 cm, layer B	BE-8036	8783	25	Animal bone	7940–7758	8158–7718	This work
Tr. 2 – sq. 4, depth 92 cm, layer B	Poz-51306	9120	50	Animal bone	8419–8273	8534–8245	This work
Tr. 1 – sq. 9, depth 206 cm, layer A, fireplace	Poz-61519	8810	50	Charcoal	8161–7752	8203–7659	Kotova et al., 2017
Tr. 2 – sq. 15, depth 126 cm, fireplace, layer A	BE-6733	9134	13	Charcoal	8329–8288	8416–8282	This work
EP of 1983, depth 140–160 cm	Ki-7667	7055	60	Animal bone	5994–5847	6057–5791	Kotova, 2003
Ep of 1987, z = 160–170 cm	Ki-4226	7170	70	Animal bone	6082–5923	6220–5900	Telegin et al., 2003
Ep of 1987, z = 160–170 cm	Ki-4022	7250	95	Animal bone	6221–6027	6370–5919	Telegin et al., 2003
Ep of 1987, z = 200 cm	Ki-7668	8020	70	Unknown	7060–6822	7138–6686	Bezus’ko 2009
“Mesolithic layer”	Ki-7669	8570	85	Animal bone	7710–7525	7936–7381	Kotova, 2003

Thus, the timeslot for formation of the layer B falls between 7910 and 6430 y. BC. The layer B obtained two dates from trench 1 and six dates from trench 2.

The samples from trench 1 came from the same depth (−140 cm); however, animal bones were selected from different sedimentological contexts, because there was an evident slope in the excavated area (Figure 2(b)). The earlier date (Poz-51419 8730 ± 50) is 7944–7600 calBC, 2σ, and the later date (Poz-51304, 7980 ± 40 BP)) is 7047–6700 calBC (2σ).

The dates from trench 2 were obtained from animal bones (three items) and charcoal from hearths (three items). The bulk of the dates encompass 8160–7198 calBC, 2σ, or 7947–7336 calBC, 2σ, when modelled. We suppose that the major part of the cultural deposits of the layer B was formed during this timeslot. There is a comparable date in the conventional dataset (Figure 8(a)), namely the date Ki-7669, 7936–7381 calBC.

In general case, the dates made on charcoal could be misleading due to "old wood effect" (Schiffer, 1986). However, this group of dates for the layer B consists of three dates on charcoal and three dates on bones, being in relatively good correspondence and, thus, they can be treated as cross-checked.

The date Poz-51296 (7810 ± 80 BP) fits well with the date Poz-51304 (7980 ± 40 BP) from trench 1 as well as with the date Ki-7668 (8020 ± 70 BP), suggesting some early VII mill. BC habitation on the surface of the layer B. The date Poz-51306 is an obvious outsider (Table 1). It corresponds rather to dating of the lower layer A. The unmovable objects (fireplaces) of the layer B were firmly placed by ^{14}C dates into the first half – middle of VIII mill. BC.

6 Lithic Assemblage

6.1 Raw Material

Chipped stone finds are almost exclusively done of flint (Figures 9 and 10). The sortation of lithic artefacts into raw material units was carried out macroscopically, by characteristics seen by a naked eye or with a magnification not more than x10. In order to describe raw material variability, we use a letter-numerical code proposed for the Middle Paleolithic materials of Temnata Cave (Pawlikowski, 1992). The first part of code stands for a country of raw material origin (in our case UA for Ukraine). The middle part denominates a site where a sample was recovered (KM1 – for Kamyana Mohyla 1). The last part of code includes an abbreviation for a raw material type (F – flint) and an index number of a lithogroup.

Among 605 artefacts (trench no. 2), the following 8 raw material groups were identified.

UA-KM1-F1 – homogenous, bright-yellow to honey-coloured flint. It is transparent when thin. It has no visible inclusions.

UA-KM1-F2 – light-grey flint of variable transparency. It could have multiple inclusions. Then, it is often turbid when seen against the light (F2a). Another variety has no visible inclusions and is partially transparent (F2b).

UA-KM1-F3 – light-grey and grey flint that evidently comes from pebbles. Maybe the same can be said about some flints of group F2.

UA-KM1-F4 – medium-grey, nontransparent or almost nontransparent flint. It has no visible inclusions.

UA-KM1-F5 – homogenous, fine-grained, dark-grey flint. It is transparent when thin and very dark, almost blackish in concretions. There are varieties: F5a – having a light stripe along the edges and F5b – evenly transparent grey.

UA-KM1-F6 – honey-coloured, nontransparent fine-grained flint.

UA-KM1-F7 – muddy-yellowish, sometimes reddish, partially transparent flint with alluvial pebble cortex.

UA-KM1-F8 – dark-grey to black, nontransparent flint. It can be striped (similar to the so-called "Volhynian" flint (Petrougne, 1995)).

Figure 9: Kamyana Mohyla 1, layer B: lithic inventory. Arrow – a burin blow negative without a counter-bulb; crossed arrow – a burin blow negative with a counter-bulb; circle – a point of impact; filled – with preserved bulb; empty – with no bulb. 1–2, 6–7, 9, 11, 13–18 - Kukrek inserts; 3–4, 8, 10, 12 – burins; 5 – endscraper, 19–20 – retouched blades; 21–26 – blades and bladelets.

This primary sortation is by no means aimed to replace petrographical definitions. The application of letter-numerical code will help to denominate lithogroups avoiding hasty "geographical" labelling.

Groups F5 and F2 comprise some 1/3 of the collection each. F8 covers 18%. Other groups encompass 12%, when taken together. A total of 4% finds are burnt or patinated to such an extent that their lithogroup cannot be identified.

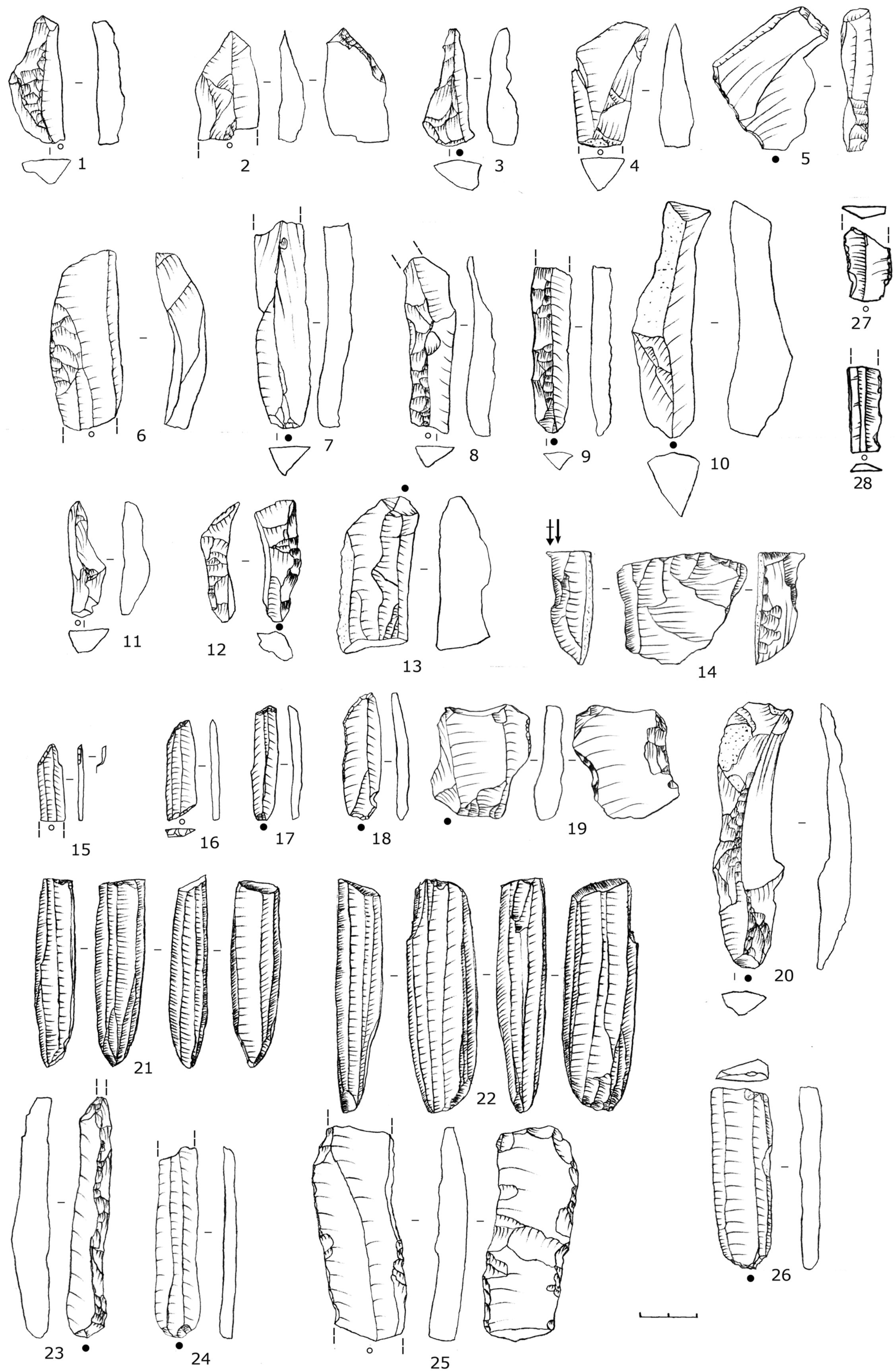

Figure 10: Kamyana Mohyla 1, layer B: lithic inventory. 1, 8–9, 23 – half-crested blades, flakes and their fragments; 2 – perforator, 3, 5, 12 – rejuvenation flakes; 4, 7, 10 – arête naturelle; 6 – overshot blade fragment; 11 – lame de cintrage; 13 – repair flake; 14 – Kukrek burin; 15–18 oblique points, 19 – retouched flake, 20 – adaptive crest; 21–22 – pencil-like cores; 24, 26 – blades, 25 – Kukrek insert.

Table 2: Summary of the collection

Group of inventory	N	%
Tested pebble	1	0.17
Chunks	6	0.99
Core-like fragments	1	0.17
Cores	2	0.33
Technical flakes	72	11.90
Of which tools	4	
Flakes and their fragments	271	44.79
Of which tools	34	
Blades and their fragments	252	41.65
Of which tools	70	
Total	605	100.00

6.2 Cores and Primary Preparation

There are not so many knapped objects in the collection (Table 2). They are a small burnt pebble tested by few removals, a core-like fragment and two pencil-like cores of elegant proportions (Figure 10(21 and 22)). A "pencil-like core" is defined by Telegin (1976, pp. 24–25) as a conical orthognathic core with a single platform and regular microblade scarring. Both cores of the layer B bear regular microblade scarring all around. A striking platform was done by a single hit and formed an angle of 60° with a part of working surface that was used last. Last removals were 5–6 mm large and should be called microblades as far as the detachments of the last series in general. Core keels were shaped by short flakes that were stroke off in the direction opposite to main series of removals. A pencil-like core has an additional platform opposed to the main striking platform (Figure 10(22)). It is not clear whether the former was used for serial débitage and the core later was reoriented or the additional striking platform was needed for correction of errors in the course of unidirectional serial knapping from the main platform.

The blades and technical flakes indicate that other types of cores were also exploited. These cores could be completely worked out or reshaped in cores of the known type. They could be removed to other sites, or vice versa their products could enter the site of Kamyana Mohyla 1 being produced somewhere else. And finally, these cores could be yet to find as far as the excavation of the site is not over.

For example, a core's platform rejuvenation flake (Figure 10(5)) was knapped off the core that had a subquadratic orthognathic platform (minimally some 30 mm wide), regular bladelet scarring on two opposing sides. This core could be reconstructed as prismatic, with two working surfaces.

Some rejuvenation flakes are 25–30 mm long – longer than platforms of pencil-like cores (Figure 10(3 and 12)). They were detached off cores with less regular laminar scarring, sometimes with a flake scarring.

Table 3: Flakes

Size (mm)	Complete	Fragments	Including			Total
			With partial dorsal cortex	Primary	Sub-primary	
0–10	22	10	1	1	1	32
11–20	73	66	18	5	6	139
21–30	41	12	10	1	4	53
30–40	5	6	1	1	1	11
More than 40	1	1				2
Total	142	95	30	8	12	237

Table 4: Blades

Width (mm)	Complete	Proximal	Medial	Distal	Total
0–7	3	27	26	9	65
7–12	15	26	24	20	85
12–20	1	11	13	7	32
Total	19	64	63	36	182

6.3 Débitage Products

Non-retouched flakes (39.5%) outnumber non-retouched blades (30%) (Tables 3 and 4).

Most flakes (81%) are 10–30 mm in diameter (Table 3). Only two flakes are larger than 4 cm. Some burning chips and maybe also some retouching chips are present among 32 chips and flakelets (0–10 mm).

Flakes with some dorsal cortex make up 21% of all flakes. They include 8 primary flakes: an opening flake (*calotte, a* flake with a butt and a dorsal surface covered by cortex completely) and 7 *éclats d'entame* (flakes with a prepared butt and a dorsal surface covered by cortex), as far as 12 secondary flakes (*éclat semicortical,* flakes that follow primary flakes and have a dorsal surface partially covered by cortex, partially by a scar of primary removal) (Inizan, Reduron-Ballinger, Roche, & Tixier, 1999).

Most blades were intentionally fragmented (Table 4). Only some 10% of the blades are complete. They often are short and thick. They did not most likely correspond to requirement for a target product and were discarded prior to fragmentation (Figure 9(23 and 26)).

Proximal (Figure 10(24 and 26) and medial fragments of blades are represented in approximately equal quantity. There is a lack of distal parts, especially in the group of microblades (0–7 mm). This disproportion could be explained in several ways. On the one hand, the blades could be fragmented into three parts. In the course of this operation, thin and fragile distal parts of microblades and narrow bladelets could be broken completely in pieces that are impossible to identify. On the other hand, some distal ends could remain unrecognized in the collection due to little regularity of cores' lower portions.

According to Stanko's suggestion (Stanko, 1982), we divide laminar pieces into blades (over 12 mm wide), bladelets (7–12 mm wide) and microblades (<7 mm wide). If we apply this sortation, microblades are dominant (46.7%) followed by bladelets (35.7%) and blades (17.6%). However, the author of this metric sortation encouraged researchers to look for a "natural" clustering of flakes in every specific case (Inizan, Reduron-Ballinger, Roche, & Tixier, 1995, p. 73; Stanko, 1982). So, we draw a graph of widths of laminar products measured by 1 mm (Figure 11). There are three maxima in the graph: 6–7, 10–11 and 12–13 mm.

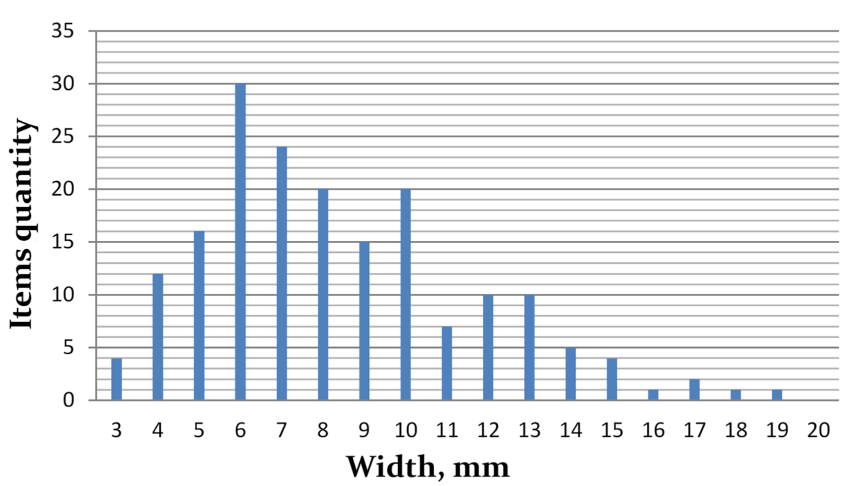

Figure 11: Kamyana Mohyla 1 site. Width of blades and bladelets plotted at 1 mm intervals.

Then, the largest group are the narrow blanks (3–9 mm wide, 106 items, 58%), followed by medium-wide lamellar products (9–12 mm wide, 42 items, 23%) and by "real" blades (12–19 mm wide, 34 items, 19%). The natural clustering reveals a tendency to knap looking for a narrow blank, while some wider blanks were also systematically produced, probably for different technological purposes. These wider blanks have less regular dorsal scarring than narrow elongated pieces; they are relatively thicker and have "wavy" sides. Most likely, they were made with another technique of detachment and maybe in the course of a separate *chaîne opératoire* or at the early stages of the same *chaîne opératoire* with narrow blanks.

Technological flakes comprise *débitage* products that can be attributed to a certain technological purpose in a framework of an operational chain.

Some flakes initialized knapping. Primary and subprimary (*cortical* and *subcortical*) blades are numerous (25%). It can point out to the on-site decortification of nodules and pebbles prior to preparation of cores.

There were several ways of starting the serial débitage (Table 5): removal of half-crested (10 items, 15%, Figure 10(1, 8–9 and 23)) or crested blades (3%), subprimary blades with triangular section, natural edges of a nodule (*arête naturelle* [Inizan et al., 1995, p. 134], Figure 10(4, 7 and 10)) or suitable surfaces of a fractured pebble (edge blades, 6 items, 9%). Typical two-sided crested blades are rare. This fact can be explained by a small size of flint concretions in general. The size of nodules left little space for elaborated preparation. Flint-knappers were forced to utilize the available relief of a pebble or a nodule in order to create a pre-core. A typical example is the blade (Figure 10(20)). In order to produce it, several removals were detached perpendicularly to the long axis of the planned blade. They alternate with suitable surfaces of previous dorsal scarring. The latter were adapted for creating an even and straight crest without complete two-sided preparation by perpendicular removals.

Semi-crested blades can be produced in the way described above and start serial débitage. They can also be used for maintenance of a core's convexity, when in the course of knapping the core's knapping surface become too flat. These varieties are not always recognizable. Only a single blade removed a portion of a regular bladelet-knapping surface next to a one-sided crest formed on a core's flank. The blade is defined as a *neo-crête*. Probably, some half-crested blades had the same function like *neo-crête*. However, they have not removed portions of knapping surface large enough for their identification as *neo-crête*. The blade's fragment was defined as a *lame de cintrage*, because it removed a portion of regular bladelet-knapping surface next to a core's flank without intentional preparation of a crest (Figure 10(11)).

Rejuvenation flakes rarely removed a striking platform completely. They can be subdivided into two groups: (1) with a detachment surface that is subparallel to a striking platform (Figure 10(5)); (2) knapped subperpendicularly to a surface of striking platform (Figure 10(3)).

Table 5: Technological flakes

Type	N	%
Burin spall	10	14.71
Crested blade (*lame a crête*)	2	2.94
Repair flake	4	5.88
Rejuvenation flake	11	16.18
Edge blade	6	8.82
Primary blade	3	4.41
Subprimary blade	14	20.59
Blade for convexity of a core (*lame de cintrage*)	1	1.47
Neo-crested blade (*neo-crête*)	1	1.47
Half-crested blade (*semi-crête*)	10	14.71
Tablette	1	1.47
Pseudo-microburin	1	1.47
Retouching chip	1	1.47
Divers	3	4.41
Total	68	100.00

The first group flakes usually removed a part of a platform. There is only one *tablette* that detached a complete striking platform. The flakes of the second group were removed along an overhang and their aim could be a management of a contact zone between a working surface and a striking platform rather than regulation of an angle of knapping or rejuvenation of a striking platform itself.

Repair and reshaping flakes usually were aimed at the removal of hinges on working surfaces by strikes from orthogonal or opposite platform (4 items, 6%, Figure 10(13)). They also comprise special flakes for shaping a core's keel. The latter are in fact pieces of keels.

Burin spalls (10 items, 15%) are morphologically similar to edge blades, and it is not always possible to distinguish these two groups. However, this situation of uncertainty can also result from the similarities between core knapping and burin detachment embedded deeply in the technology of the site. They can also be seen in the morphology of burins *versus* a shape of some cores (see further).

There is also a pseudo-microburin in the collection. This type was defined by Nuzhny (Nuzhnyj, 2008). It is an outcome of a knapping error while abruptly retouching a long edge of a bladelet. A single retouching chip was identified. They are surely more numerous in the collection but only one artefact bears every diagnostic morphological trait of these products of tool shaping (Demidenko, 2004).

Summing up, we can state that the technological flakes poorly correspond to the cores so far found in the middle layer of KM1. This incongruence is both metric and morphological. Thus, one can conclude that discarded cores are particular products of the final stage of the *chaîne opératoire*. Other types of cores are currently missing in the collection and evidence of their existence is exclusively indirect.

6.4 Tools (Artefacts with Secondary Treatment) (Table 6)

Retouched flakes constitute 14% tools (Figure 10(19)). Retouch is mostly marginal, irregular. However, there are also tools with a "scraper-like" retouch (semi-abrupt, sometimes "high" lamellar) not forming a scraper front. A single flake was obliquely truncated.

Retouched blades make up the most numerous group (a little bit less than 1/4 tools, Figure 9(19–20)). They mostly bear marginal, simple retouch along a side or two sides. Sometimes, retouch is alternative or alternate. Fractures of blades were not completely retouched. Some bladelets bear extremely regular semi-abrupt retouch (one- or two-sided).

Notched or denticulate blades and bladelets – six items (Figure 10(27–28); 5.6%). This type was found in the assemblage of the Kukrek site (the eponymous site of the Kukrek culture). There it was interpreted as an influence of the Crimean Mountainous culture (the Murzak-Koba culture) (Telegin, 1982, pp. 101–102). Kamyana Mohyla 1 is situated quite far away of the Crimean Mountains. Thus, it is unlikely that notched blades of the site under study are related to connections with the Murzak-Koba culture.

A backed bladelet is atypical. Retouch is almost abrupt (an angle of retouching is somewhat smaller than 90°) and it cut only the edge of the blank not penetrating deep in the blank's body. Blades with ventral trimming are similar to Kukrek inserts but lack some diagnostic traits of them. Some blades with trimming can be classified as pseudo-Kukrek inserts in definition of Telegin (Telegin, 1982, p. 100).

Kukrek inserts belong to the type identified exclusively by Soviet and post-Soviet researchers. They are defined as blade's fragments with retouch and ventral trimming (Figure 9(1, 2, 6, 7, 9, 11 and 13–18)). G. A. Bonch-Osmolovsky was the first to define them. Danilenko interpreted some inserts as "cutters" (prorezy-vateli) for cutting grooves in bone, antler and wooden hafts (Danilenko, 1969). The current concept of "a Kukrek insert" was developed by Telegin (Telegin, 1982, p. 98).

The function of these tools was identified by G. V. Sapozhnikova with an aid of use-wear analysis of a sample of 103 inserts from the Kukrek site. They were intentionally produced by retouching notches and a consequent fracture of laminar blanks. Flat ventral trimming resulted from their use as planing knives on hard wood and bone (Sapozhnikov & Sapozhnikova, 2011). The similar results were obtained by B. Voytek (Biagi & Kiosak, 2010) on a smaller sample of Kukrek inserts from the Myrne site (SW Ukraine).

Table 6: Tools

No.	Type	N	%	On blades	On flakes	On technological flakes
1	Retouched flakes	15	13.89		15	
	– Obliquely truncated flake	1	0.93			
2	Notched flakes	2	1.85		2	
3	Blades with retouch	26	24.07	26		
	– Along 1 side	12	11.11			
	– Along 2 sides	7	6.48			
	– Irregular edge retouch	2	1.85			
	– Semi-abrupt retouch	3	2.78			
	– With retouched ends	2	1.85			
4	Notched blades	6	5.56	6		
5	Backed bladelet	1	0.93	1		
6	Blades with ventral trimming	6	5.56	6		
7	Kukrek inserts	20	18.52	19		1
8	End-scraper	1	0.93		1	
	– On a flake's end	1	0.93			
9	Burins	21	19.44	5	15	1
	– Dihedral	6	5.56		6	
	– Double and multiple	6	5.56	5		1
	– Kukrek	5	4.63		5	
	– On a truncation	1	0.93		1	
	– Simple	3	2.78		3	
10	Perforator	1	0.93		1	
11	Points	6	5.56	6		
	– Oblique	5	4.63	5		
	– Truncated blades (angle of truncation <45°)	1	0.93	1		
12	Retouched technological flakes	2	1.85			2
13	*Divers* (blade with flat dorsal retouch)	1	0.93	1		
	Total	108	100	70	34	4

The field work of 2011–2013 yielded a notorious selection of Kukrek inserts and related artefacts (pseudo-inserts, medial fragments of blades with retouch [blanks for inserts], blades with ventral trimming [un-prepared inserts]).

In order to produce a Kukrek insert, the ancient flint-knappers selected blades 11–18 mm wide, 12–44 mm long (mostly 20–30 mm long) and 3–7 mm thick. The blades had 2–3 dorsal negatives. A single blade bears remains of lower parts of scars that resulted from flakes removed perpendicularly to the long axis of the blade (Figure 9(6)). It is a certain variety of *sous-crête* detachment following the removal of a crested blade.

Blades were intentionally fragmented in a certain way. At a point of future fracture, a notch was prepared by ventral or dorsal retouch. Then, a remainder of the blade's end was simply broken. Mostly a single end of insert was prepared in this way, while another end was fractured without preparation. Maybe the first break was unrestricted while the second break should be done at a certain point in order to obtain a blank of a desired length. Some artefacts are blades' fragments obtained in the way that was described above. They have no ventral trimming and, thus, we tend to interpret them as blank "Kukrek inserts" prior to utilization (Figure 9(22)).

There is a "stratigraphy" of trimming scars and "interstratification" of trimming and burin scars. Sometimes, a part of the trimming scar was removed by a burin strike and a part of the later was removed by a next trimming. Thus, we should treat burin scars on the Kukrek inserts either as a way to repair the tools in the course of their use or as a variety of "macro-traces" on inserts related to their use and/or hafting (Figure 9(11, 17–18)).

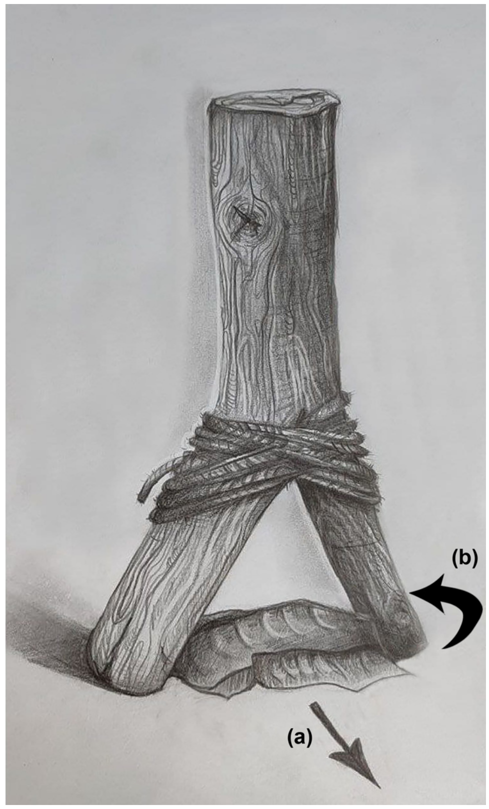

Figure 12: A hypothetical reconstruction of the way Kukrek inserts were hafted. (a) Direction of force application; (b) rotation movement resulting in characteristic macroimpact fractures. Concept: S. Radchenko, Drawing: D. Martynova.

Some Kukrek inserts probably were broken in two. They bear traces of intentional fracture only on one end, while the other end can be a typical fracture of unintentional breakage with a characteristic "tongue" (Demidenko, 2004). Moreover, they are double as short as a "standard" Kukrek insert (Figure 9(1–2)).

This cross-cut break was not the only damage pattern observable on Kukrek inserts from Kamyana Mohyla 1. Some inserts have a very characteristic damage on an end. It reminds a transversal burin scar, but it is very flat and has a convex shape. The "macro-trace" of this type could result from some force that was applied perpendicularly to a long axis of the tool and has driven the insert's end out of the haft with a rotating movement (Figure 12b).

Thus, Kukrek inserts are working elements of composite tools. These tools were used for planing hard organic materials (wood, antler, bone). Their reconstruction can be only hypothetical at the moment (Figure 12). Telegin remarked that Kukrek inserts cannot be placed in their hafts by long sides because some inserts were curved in profile (Figure 10(25)). We suppose that they were hafted by their ends which were inserted in grooves or some other type of binding. That's why the length of the inserts was relatively standardized. When hafted like this, both sides of an insert were free and probably were used with a mechanic of movement similar to modern hard planes with force applied perpendicularly to a long axis of the insert (Figure 12a).

The only end-scraper is a simple end-scraper on a primary flake with an opposite end retouched too (Figure 9(5)). It is the only end-scraper in the collection of 2011–2013. There are more end-scrapers in older collections. This anomaly is still to be understood. Maybe it is related to a function of the zone excavated in the twenty-first century.

One *perforator* was shaped by fine marginal retouch on a flake (Figure 10(2)).

Fine marginal retouch is also present on some *retouched technological flakes*: burin spall and half-crested blade.

Burins are mostly composed of three distinctive groups: double/multiple burins on blades and dihedral and multiple (Kukrek) burins on flakes and simple burins on flakes. Double burins were done on blades, usually by two burin strikes placed on both sides of a single end of the medial fragment of a blade (Figure 9(3 and 8)). Only one double burin was done on a truncation prepared by an abrupt retouch (Figure 9(12)). Similar tools were identified by L. Domanska at Janisławice site Dęby in Lesser Poland. She called them "*Dęby* inserts" and supposed that they evidence long-distance relations of Mesolithic population of Polish lowland and inhabitants of Crimea and Caucasus (Domanska, 1987). We propose to retain the name "*Dęby burins*" for this type.

"*Kukrek burins*" were defined in several contradicting ways. They could be understood as "simple burins on chunks of flint" (Telegin, 1982), burins on flakes with flat burin scar (Stanko, Petrougne, & Maksymiuk, 1981), multiple burins on flakes (Stepanenko, 1977). We accept the latter approach.

If defined this way, "Kukrek burins" resemble secondary cores (cores on flakes). This point is supported by some refitting in the KM1 collection. The artefact N 451 is a "Kukrek burin" from a typological point of view (Figure 13). It was refitted with two "burin spalls." So, its knapping sequence was as follows:

1. A massive (9 mm thick) flake was selected for future knapping;
2. A blade-like flake was removed along a prominent dorsal arris of the flake. A strike was delivered on the flake's butt. The removal finished with a hinge.
3. The hinge (and an adjacent side of the flake) was detached by a burin strike. It fell on the platform opposite to the flake's butt and resulted in rather typical "burin spall," triangular in section (N 446).
4. The distal part of the burin scar was used as a striking platform for several (2 or 3) elongated flakes detached along another side of the massive flake. The last flake hinged. There were some attempts to remove the hinge from the same platform.
5. The core-flake was reoriented again. An elongated "burin spall" was detached from the opposite platform (N 454).
6. The distal end of the second burin scar was used as a striking platform for removal of some (3–4) flakes.

Thus, this core-flake can be classified as a multiple burin on a flake, while in fact being rather a secondary core. Another refitting comprises several flakes removed from a secondary core subsequently.

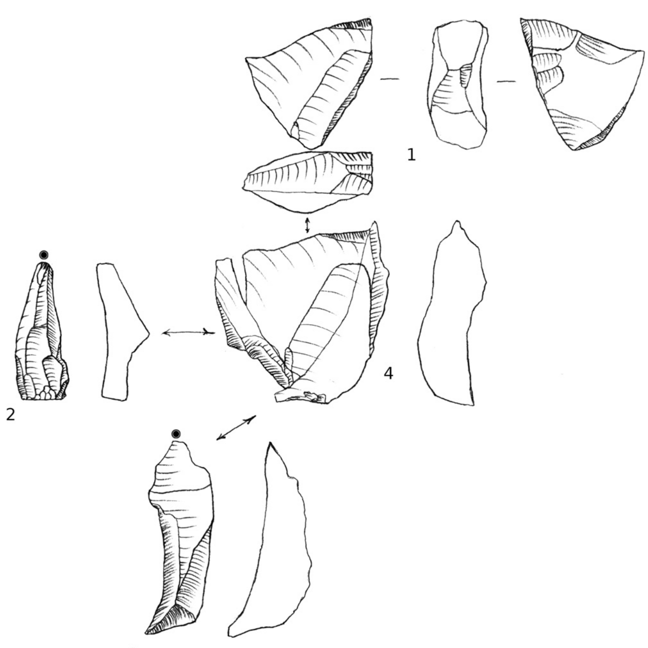

Figure 13: Refitting of "Kukrek burin."

Another characteristic example is a flake taken off a slate of fine-quality flint (Figure 10(14)). Multiple detachments were removed off flanks of the flake, as far as off its flat ventral surface. This item is a "Kukrek burin" in a typological light; however, it was evidently knapped as a "flank core" in accordance with the knapping method described for this type of cores.

So, the collection of Kamyana Mohyla 1 yielded important data that gave us a possibility to ask whether "Kukrek burins are tools or cores?" (McPherron, 2007).

While the way of "Kukrek burins" manufacture differs drastically from the exploitation of regular bladelet cores found on the site, one can argue that the small size and distinctive shape of the resultant products make it difficult to see for what purpose they are produced. There are few tools on flakes that are definitely removed off these "flaked flakes." And last but not least – some cores on flakes could be reutilized as tools. Thus, we can doubt that "Kukrek burins" are really burins. However, at the moment, we are far from a decisive answer to the basic question: "tools or cores?"

Points were produced by an oblique truncation of microblades and bladelets (Figure 10(15–18)). Sometimes, sides of the truncated blank were also retouched. A single specimen was double-truncated with a resulting shape that resembles a parallelogram (Figure 10(16)). Meanwhile, proportions of the above-mentioned point clearly exclude it from geometric microliths' group (G.E.E.M., 1969; Laplace, 1964). There is a macro-impact scar at the point (Figure 10(15)). It could indicate a projectile function for this item and the type in general (Nuzhnyj, 2008).

Similar "oblique points" are known in Kukrek-like assemblages: in Crimea (Stepanenko, 1977, Figure 1(11–14)), in the Dniester region (Chernysh, 1975), in the North Pontic area and in the Dnieper Rapids region (Telegin, 2002, Figures 19: 13, 28: 16, 37).

Telegin demonstrated that oblique points are typical for the Kukrek aspect of Crimea and the North Azov region, while they are rare in other Kukrek-like regional aspects. Kudlaivka and needle-like backed points are more characteristic for Dnieper Rapids sites, and Abuzova Balka points (backed and truncated) are more relevant in the North Pontic area (Telegin, 1982, pp. 101, 107, 116). The layer B yielded two fragments of bone points (Figure 1).

Some items of portable rock art can originate from the layer B of Kamyana Mohyla 1 (Kotova, Kiosak, Radchenko, & Spitsyna, 2018) as well as some Mesolithic engravings can be detected in the nearby stone mound of Kamyana Mohyla (Radchenko et al., 2020).

7 Interpretation

The layer B of Kamyana Mohyla 1 is an excellent example of the Kukrek cultural aspect and provides a possibility to discuss the concept of "Kukrek" in general.

V. Danilenko was the first to suggest that Kukrek typological peculiarities result from technological necessity. The Kukrek technology was aimed at production of grooved bone points armed with elongated bladelet inserts (Danilenko, 1969). Later, this opinion was developed further. The grooved bone points were preferred due to large game hunting of Kukrek people, which was carried out in the open steppe (Yanevich & Nuzhnyj, 1987, compared to Kitagawa et al., 2018).

The pressure technique is traditionally assumed to form a basis of Kukrek lithic technology (Yanevich & Nuzhnyj, 1987). The Kamyana Mohyla 1 collection demonstrates that some target blanks were knapped in another technique. They are relatively thick and short blades with somewhat irregular dorsal pattern. Such blanks were required for the production of Kukrek inserts and Dęby burins and could be produced in some variety of direct knapping technique. Pencil-like cores and their products (microblades and narrow bladelets [up to 9 mm wide]) were worked by pressure technique, which is proved by the extreme regularity of products and the small size of finalized cores. Cores are too small for a meaningful knapping by any other technique except pressure.

Are we dealing with two separate *chaînes opératoires*? The definite answer should be evidently searched in refitting of Kukrek cores. At the moment, Kamyana Mohyla 1 collection includes exclusively pencil-like cores. Other cores are missing so far. Thus, it appears that the cores were worked by direct strikes of hammer in order to obtain larger blades, and later, these cores were reshaped for utilization by pressure in search of regular but rather slender and narrow blanks for projectile points. Both techniques of knapping could be united in a single reduction sequence (Girya, 1997).

A separate *chaîne opératoire* should be reserved for knapping of "Kukrek burins." It is very likely that at least some burins are in fact cores on flakes. Their target product was an elongated flake.

The pressure technique enabled Kukrek flint-knappers to work out cores almost completely. Massive flakes were employed for production of secondary flakes. Both approaches aim at the economy of raw material. The lack of flint is probably connected to relatively higher degrees of Kukrek population mobility.

Kukrek is an original Mesolithic technocomplex in the southern East Europe. It finds no parallel in classical cultural sequences of the Southern and the Western Europe. According to current beliefs, the first period of Kukrek took place in the Early Mesolithic (Yanevich, 1987), while classical "developed" Kukrek sites are attributed to the Late Mesolithic (Stanko, 1982; Stanko & Kiosak, 2010; Telegin, 1982). Later, it is believed that Kukrek took part in the formation of some Neolithic cultures (Zaliznyak, 1998, 2005; Zaliznyak & Tovkailo, 2007; Zaliznyak, Tovkailo, Man'ko, & Sorokun, 2013). This exceedingly long timeframe is accompanied by an overwhelmingly wide territorial range. "Kukrek-like" sites are known from Prut River in the west (Figure 2(1 and 2)) till Molochna River in the east (Figure 21b(14–15)) and from forested lowlands (Polissia) in the north (Figure 2b(20)) till Crimean Mountains (Figure 2b(13 and 22)) in the south (Zaliznyak, 2005) (see Appendix).

The definition of the Kukrek cultural aspect is basically different from any other definition of a Mesolithic culture in Ukraine. While the latter are grounded on microlithic projectile point's typology, the Kukrek specificity is sought in other functional tools. Their shapes partially result from use-wear (Kukrek inserts) or from technological peculiarities of "secondary" cores' knapping (Kukrek burins). The Kukrek cultural community (in Telegin's definition) includes variants which have different microlithic projectile points' assemblages and, thus, have probably different cultural affiliation (Telegin, 1982). Moreover, sites named "Kukrek" yield sometimes radically different typological composition of lithic inventory. Some characteristic Kukrek traits are often diagnosed separately from the total complex of Kukrek technologies and types. Then, a site is labelled "Kukrekoid," although this term means nothing. Instead, this discursive practice of term-usage leads to blurring the initial notion of Kukrek. It appears to be associated with various phenomena that are not similar to Kukrek *sensu stricto* neither in chronological and territorial dimensions nor by techno-typological parameters. For example, conic cores found in the Late Buh-Dniester para-Neolithic sites are not related to Kukrek in any way. They belong to a different technological context and were utilized in a different way (Gaskevych, 2005).

The layer B of the Kamyana Mohyla 1 site finds close parallels in the sites of the second stage of Kukrek in Crimea (Yanevich, 1987). Its lithic collection resembles the assemblages of Kukrek, Domchi Kaia, Ivanivka (Figure 2(2, 9–10 and 22)) by several characteristics:

1. Conical cores often bear fine patterns of lamellar detachments all over their perimeters;
2. Burins outnumber end-scrapers;
3. There are both double burins on blades and multiple burins on flakes;
4. End-scrapers usually are done on the end of a blank; there are few circular and subcircular types of end-scrapers;
5. Kukrek inserts are done on blades fragments, wide and massive. Kukrek inserts are often the best represented type in the assemblage;
6. There are oblique points in the microlithic assemblages;
7. Geometric microliths are few and atypical. In fact, any case of geometric microlith detected in the cultural layer of these sites can be posed under doubt due to probable post-depositional disturbances.

A similar lithic assemblage was recovered from the Ihren VIII site in the Dnieper valley (Telegin, 1982, 2002; Zaliznyak, 2005). However, the vast collection of Ihren VIII probably contains also some materials of other chronological periods and cultural aspects (Biagi & Kiosak, 2010).

There are several sites with Kukrek lithic complexes, which were dated by the radiocarbon method. Unfortunately, they usually yielded artefacts of other cultural aspects too (Kiosak, 2019). Some Kukrek sites yielded early Holocene dates, usually alongside with dates of another age, the eponymous site being the first and the best example (Telegin, 2002). The supposedly "pure" complex was recovered from the lowermost layer of Melnychna Krucha site (SU4, Figure 2b(21)). It resembles the assemblage of the layer B of Kamyana Mohyla 1 by presence of conical cores, multiple burins, Kukrek inserts, similar types of nongeometric projectiles. It is situated on the Southern Buh River. Melnychna Krucha SU4 was dated to the time span of 7520–7315 calBC, 2σ (Kiosak et al., 2021; Salavert et al., 2021).

The site of Ihren VIII (Figure 2b(16)) received somewhat contradictory dating despite the fact that most samples were selected from dwelling-pits. The largest and the most consistent series of dates from several laboratories (Kyiv, Groningen, Oxford and Berlin) on different types of datable material (bones, shells, charcoal) fell into the first half of VIII mill. calBC (Biagi & Kiosak, 2010).

The abundant chipped stone assemblage of Kukrek outlook was gathered in the excavations of the Dobrianka III site (Figure 2b(19)) situated 55 km north-east of Melnychna Krucha (Zaliznyak et al., 2013). The radiocarbon chronology of the Dobrianka III Kukrek complex is dubious. The site yielded ^{14}C dates of the Bronze Age and the late VII mill. BC (Biagi, Zaliznyak, & Kozlowski, 2007; Zaliznyak et al., 2013). A single date refers to the Preboreal period (Lillie, Budd, Potekhina, & Hedges, 2009), and some Early Mesolithic microliths found alongside with numerous Kukrek implements can indicate the occupation of the site also during this time-slot (Kotova, 2015, p. 44).

Similar dates were obtained from cemeteries in the region of the Dnieper Rapids. Some cemeteries yielded backed points consistent with Kukrek attribution. Their ages can be distorted by reservoir effects (Kotova, 2018; Lillie & Jacobs, 2006; Lillie & Richards, 2000; Lillie et al., 2009).

The sums of radiocarbon dates for Kamyana Mohyla 1, Ihren VIII and Melnychna Krucha are similar (Figure 8b, Table A1). Probably, these sites were settled in roughly the same time intervals. So, taking into account also the similarities observed in the artefactual complexes of these sites, we can reasonably suppose, that their sequences reflect a general pattern of change of Mesolithic culture in the steppe of the North Pontic region.

The Early Mesolithic complexes of the layer A of the Kamyana Mohyla 1 site predate the "classic" Kukrek industry of the layer B, which is well defined due to their stratigraphic position and by radiocarbon analysis. The layer A inventory is characterized by a low percentage of formal tools. The complexes of "classic" Kukrek form a very homogenous group from a point of view of the lithic typology and technology. They share the characteristics listed above. The radiocarbon dates indicate their development can be placed between 7800–6700 y. BC.

Later on, another type of industry appears in the Late Mesolithic. It resembles "classic" Kukrek by presence of conical cores, multiple burins, Kukrek inserts, nongeometric microliths formed by a combination of backed side and truncated end, but there are several important differences:

1) Cores for serial production of bladelets and microblades are often one-sided, not worked all around the perimeter of the striking platform;
2) There are an elevated percentage of microblades in particular and microlithic (less than 2.5 cm in any dimension) tools in the assemblages;
3) Kukrek inserts are done on bladelets not on blades like before. They are less regular and atypical. In fact, they can be classified as pseudo-inserts (term of Telegin [1982]);
4) End-scrapers are more numerous than burins;
5) End-scrapers are mostly microlithic, often circular or subcircular or on the end of a bladelet fragment;
6) There are elongated double-truncated bladelets ("low trapezes"), sometimes in representative series;
7) Some microlithic isosceles trapezes are found in these complexes;
8) Nongeometric microliths are usually backed points.

The numerical differences in ratio of different tools should be treated with caution as far as they can result also from different functions of sites. However, at the moment, they are a fact, which is observed by comparison of the available datasets. Probably, further research will clarify this issue.

D. Gaskevych described the complexes of this type as “Kukrek cultural tradition” (in the context of the para-Neolithic Buh-Dniester culture, Gaskevych, 2005). Recent studies suggest that the “Kukrek cultural tradition” thrived before the first arrival of pottery in the Southern Buh region (Kiosak et al., 2021). O. Yanevich recognized such assemblages and named them as the “third stage of Kukrek culture.” They are known in Crimea on sites of Olexiivska Zasukha, Frontove I, Frontove III, Dolynka, Martynivka (Figure 2b(8, 11, 12)). Interestingly, in Crimea, some sites yielded para-Neolithic pottery (some potsherds of vessels with a pointed bottom and comb imprints) alongside with lithic complex of “Kukrek cultural tradition.”

Apparently, materials of classic Kukrek and Kukrek cultural tradition were found together in the cultural layer of the Ihren VIII site. At the Melnychna Krucha site, the “classic” Kukrek stratigraphic unit (SU4) was covered by the sediments containing implements of the “Kukrek cultural tradition” (SU3), 6380–6230 years BC (Kiosak & Salavert, 2018; Kiosak et al., 2021). The layer C of the Kamyana Mohyla 1 site also resembles (to a lesser extent) Kukrek-like sites of Dnieper Rapids region. Some Dnieper Rapids sites are already related to Early Neolithic (para-Neolithic in the terminology of Nowak, 2007) Sursky culture (Kotova & Tuboltsev, 2013; Tuboltsev & Kotova, 1996). Unfortunately, none of the complexes combining pottery and tools of “Kukrek cultural tradition” is homogenous. Each can be doubted on the taphonomic grounds. So, the exact relation of “Kukrek cultural tradition” and the earliest pottery in the Meotic region is still to be clarified. Hopefully, further work on the layer C of the Kamyana Mohyla 1 site will shed additional light on the issue.

In summary, there are two cultural aspects, which can be defined on the general background of Kukrek technocomplex: the “classic” Kukrek (or Kukrek *sensu stricto*) and the “Kukrek cultural tradition” (Figure 14). These two aspects do not exhaust the variability of complexes united under the heading “Kukrek.” However, they stand out as two relatively homogenous units with clear chronology: the “classic” Kukrek existed mostly in VIII mill. BC, while the “Kukrek cultural tradition” lasted in the second half of VII mill. BC and is probably partially contemporaneous with the “ceramization” of the region.

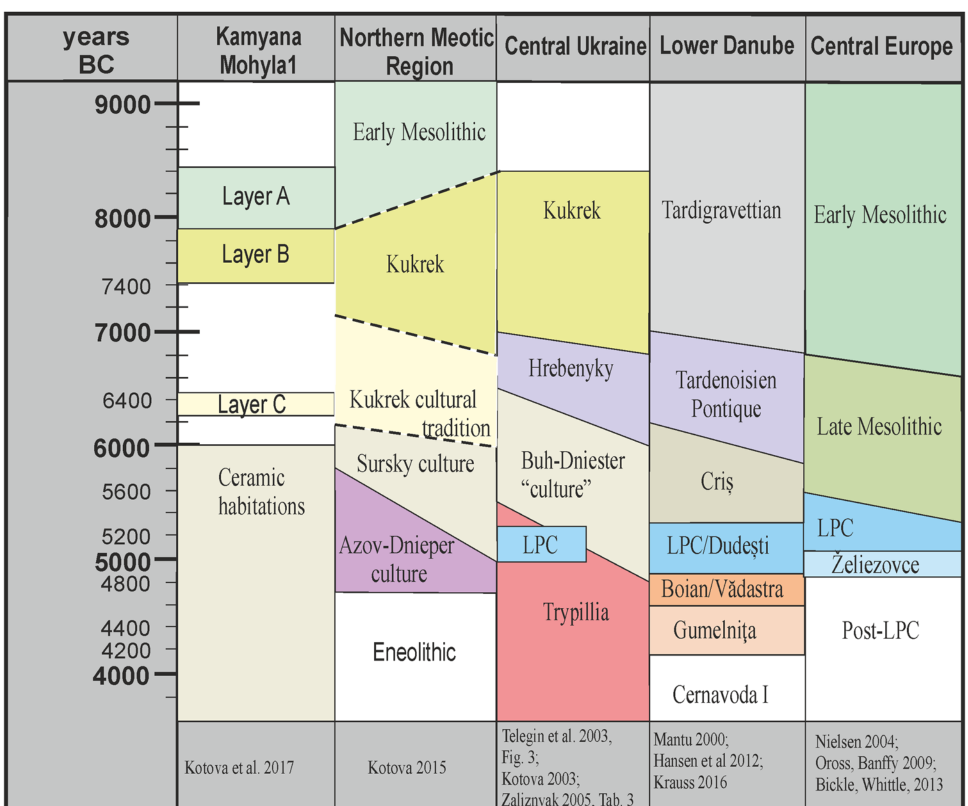

Figure 14: Chronological table for the Kamyana Mohyla 1 site in the context. Dotted line indicates uncertainty in the chronological position of the indicated transition.

8 Conclusion

The Kukrek cultural aspect was defined in the late 1960s (Danilenko, 1969; Stanko, 1967). Since then, its concept underwent certain dissolution due to imprecise usage of the term "Kukrek." At the moment, Kukrek is obviously too extended to be homogenous. The current state of art enables us to define two relatively homogeneous successive units among the sites of Kukrek *sensu lato*: the "classic" Kukrek and the "Kukrek cultural tradition." These two aspects existed in succession, at least in the Meotic steppe region as evidenced by materials of the Kamyana Mohyla 1 site. Later, an exact realization of Kukrek technocomplex should be understood region by region and period by period.

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Appendix

Table A1: Chronology of selected Kukrek sites

Site name	Provenance	Lab. number	Date BP	SD	Material	CalBC (1 s)	Calbc (2 s)	Reference
Ihren' VIII	Pit-dwelling 2	Bln-1797/2	9940	70	Unident. Charcoal	9630–9330	9760–9280	Telegin, 2002
Ihren' VIII	Pit-dwelling 8	OxA-17489	8885	40	*Cervus* bone	8180–7970	8220–7840	Lillie et al., 2009
Ihren' VIII	Pit-dwelling 8, lowermost layer	GrA-33113	8880	45	Mammal long bone flake	8202–7966	8232–7836	Biagi and Kiosak (2010)
Ihren' VIII	Pit-dwelling 4, lowermost layer	GrA-33112	8695	45	Mammal long bone flake	7733–7610	7934–7592	Biagi and Kiosak (2010)
Ihren' VIII	Pit-dwelling 1	Ki-950	8650	100	Unident. Charcoal	7890–7600	8150–7500	Telegin, 2002
Ihren' VIII	Pit-dwelling 2	Bln-1797/1	8570	70	Unident. Charcoal	7680–7550	7770–7500	Telegin, 2002
Ihren' VIII	Pit-dwelling 4	Bln-1798	8550	80	Unident. Charcoal	7670–7530	7780–7450	Telegin, 2002
Ihren' VIII	Pit-dwelling 8	OxA-17491	7640	90	Fish bone	6590–6431	6655–6264	Lillie et al., 2009
Dobrianka-III	Cultural layer	OxA-17490	9115	45	Bone	8420–8272	8454–8252	Lillie et al., 2009
Dobrianka-III	Burial	OxA-222-33*	7227	40	Human bone	6202–6028	6210–6018	Lillie et al., 2009
MKrucha	SU4	BE-7636	8368	23	Bone	7478–7360	7496–7339	Kiosak et al., 2021
MKrucha	SU4	BE-7635	8311	24	Bone	7456–7353	7486–7322	Kiosak et al., 2021
MKrucha	SU4	BE-10309	8344	23	Bone	7452–7343	7480–7310	Kiosak et al., 2021
Kukrek	Layer 6	Ki-954	9600	150	Shell	9221–8805	9324–8549	Telegin, 2002
Kukrek	Layer 3	Ki-895	7620	110	Shell	6595–6385	6685–6233	Telegin, 2002
Kukrek	Layer 5	Bln-1999-1	7320	65	Shell	6227–6086	6371–6034	Telegin, 2002
Kukrek	Layer 5	Bln-1799-2	7285	70	Shell	6221–6074	6358–6011	Telegin, 2002