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VARIATION IN MIDDLE AND UPPER PALEOLITHIC REDUCTION TECHNOLOGY AT KARA-BOM, THE ALTAI MOUNTAINS: REFITTING STUDIES*

Primary reduction techniques used at the site of Kara-Bom in the Altai Mountains, are analyzed using the refitting method. In previous studies, the Kara-Bom assemblages provided the basis for reconstructing the evolution of lithic industries in the Altai Mountains over most of the Middle Paleolithic and at the early stages of the Upper Paleolithic (ca 60–30 ka BP). Under the new stratigraphic subdivision of Kara-Bom, four habitation stages are described. The refitting of artifacts from the Middle Paleolithic (MP2) layer indicates Levallois unidirectional convergent flaking aimed at producing points and blades as a co-product of reduction sequences. Based on cores and groups of spalls from the Upper Paleolithic layers UP2 and UP1, the variation of Upper Paleolithic reduction techniques is reconstructed and a conclusion is made that significant changes in core reduction occurred: the Middle Paleolithic (Levallois) flat unidirectional technique gave way to bidirectional volumetric subprismatic and prismatic reduction of the Upper Paleolithic type. The Kara-Bom assemblages appear to have been stable variants of blade technology aimed at producing large and medium-sized blades as well as reduction of narrow-faced cores aimed at producing bladelets. The comparison of Kara-Bom with contemporaneous industries of northern and eastern Central Asia suggests that the earliest Upper Paleolithic assemblages (before 35 ka BP) show a marked predominance of the Kara-Bom-type reduction techniques.

Keywords: *Altai Mountains, Middle Paleolithic, initial Upper Paleolithic, early Upper Paleolithic, lithic reduction techniques, refitting method.*

Introduction

The definition of the initial Upper Paleolithic was first formulated on the basis of the chronologically early Upper Paleolithic Emiran industry from layer 4 of the Boker Tachtit site in Israel (Marks, Ferring, 1988). Later, S. Kuhn expanded this definition by including the Levantine cultural entity which in chronostratigraphic terms was located between the Levantine Mousterian and the Upper Paleolithic Ahmarian, and was characterized by a combination of Levallois and laminar methods of subprismatic lithic reduction ((Kuhn, Stiner, Güleç, 1999); for a discussion of the background, see (Kuhn, Zwyns, 2014)). As more data have been acquired as well as enhanced methods of dating, it has become clear

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how widespread those industries of the initial Upper Paleolithic are which occupied chronostratigraphic positions between the industries with undoubtedly Middle Paleolithic features and the assemblages manifesting expressed features of the Upper Paleolithic. Such industries have been found in the Levant, Central and Eastern Europe, the Altai Mountains, the Russian Trans-Baikal region, as well as Northern China and Mongolia. It is evident that significant technological and typological variability of the industries associated with the initial Upper Paleolithic requires a more precise definition. Refitting of stone artifacts can provide important information for this purpose, since the refitting method makes it possible to reliably reconstruct the operating sequences in lithic reduction, which were followed by the ancient humans. Only some assemblages of the period under study possess extensive series of reconstructed lithic reduction sequences. These assemblages include the collection from the sites of Brno-Bohunice and Stránská skála in the Czech Republic, and Boker Tachtit in Israel (Škrdla, 2003a; Volkman, 1983). However, the analysis of reduction technology has not yet been made using refitting of the materials from Northern and Central Asia, dated to the initial Upper Paleolithic.

The collections from the multilayer Kara-Bom site deserve particular attention for the study of ancient stone processing technologies which were employed in the initial Upper Paleolithic, and for the problems of continuity and inter-relations between the Middle and Upper Paleolithic technologies in Northern Asia. The data uncovered at Kara-Bom demonstrated for the first time that the industries of the initial Upper Paleolithic also gained ground over the territory of Northern Asia. The archaeological assemblages from the deposits of the site became one of the sources for reconstructing the development of lithic industries on the territory of the Altai Mountains for much of the Middle Paleolithic and the early stages of the Upper Paleolithic (Derevianko, Petrin, Rybin, 2000; Derevianko, Shunkov, 2004). The studies of lithic raw materials from the site, which have been carried out in recent years, were aimed at reconstructing the spatial and stratigraphic structure of the site, and also recreating the strategies of primary reduction using the refitting method. These studies resulted in establishing variability of the Middle and Upper Paleolithic technologies of lithic reduction, the range of technical methods followed by the carriers of the Kara-Bom cultural tradition of the initial Upper Paleolithic, in assessing the likelihood of technological continuity between the Middle and Upper Paleolithic industries of Kara-Bom as well as differences between the assemblages of the initial and Early Upper Paleolithic of the site.

The multilayer open-air Paleolithic site of Kara-Bom is located in the Yelo Depression, which is part of the intermountain depressions in the central area of the Russian Altai (50°43′N, 85°42′E). The site is located at the foot of the right slope of the Altairy and the Semisart river valley near the confluence of these rivers. Archaeological remains were deposited in a sedimentary unit of slope genesis leaning against a vertical rock-wall of step-like slatestone ledges; the wall protected the inhabitants of the site from the prevailing winds. The modern slope of the sediment surface reached 15–20°. The site has southern exposure. A long-living unfrozen spring is located at the foot of the cliff; a low mountain range in the form of a semi-circus is next to the site; its pass allowed for communication with the neighboring valley (Arkheologiya i paleoekologiya…, 1990).

The thickness of sedimentary deposits at the site reached approx. 5 m. A significant part of the site was composed of proluvial deposits and was damaged by the melting of glaciers and temporary streams. Excavation works at the site were carried out with some interruptions from 1980 to 1993. The area of the site was divided into four excavation zones. A zone of approx. 150 m^2 adjacent to the rock remained in undisturbed condition. It is composed of loess-like loam filled with detrital materials. The base of the cross-section at this excavation zone was formed by clay loam mixed with decomposition products of the weathering crust. Most of this area (about 100 m^2) was unearthed during the excavations of 1980–1991. The majority of research materials from excavation pit No. 1 have not yet been published, but a small part of materials from the excavations of 1992–1993 (excavation pit No. 4) has been published (Derevianko et al., 1998). The study of sediments from the excavation at Kara-Bom made it possible to identify six Upper Paleolithic habitation levels (UP6–1, the numbering starts from the top) and two Mousterian horizons (MP2 and MP1 with the former at the bottom).

Lithic industries of the Kara-Bom site mostly used raw material of local origin—cherts (acidic aphyric effusive rocks). The inhabitants of the site would bring stone raw material from a distance of up to 5 km directly from the slopes of the nearby Aptyrga mountain, where the outcrops of this rock were available. Weakly rounded nodules of the same rock, moved by the waters of the rivers which flow through the valley, were also used (Kulik, Shunkov, Petrin, 2003). Since these lithic raw materials were only slightly exposed to the impact of riverbed processes, individual stones had mostly subrectangular, elongated, or bar-like shapes. Apparently, the stones used by the inhabitants of the site were of the best quality out of the varieties of raw materials available in the Altai Mountains in the Paleolithic. The structural patterns, color of the rock, and also the condition of the natural surface make it possible to identify the debitage belonging to individual raw material units.

Levallois convergent technology in the Middle Paleolithic assemblage

Cultural deposits of the Kara-Bom site contain the Middle Paleolithic component represented by the assemblage MP2 (Mousterian horizon No. 2 according to the previous classification in (Derevianko et al., 1998)) (Belousova, Rybin, 2013). The assemblage was located in the lithological layer 9 which was composed of brownish-gray loam of slope genesis. A small assemblage from the cultural horizon MP1 probably associated with the initial Upper Paleolithic, was located in horizon 9B; it contained fragmentary traces of humification. Assemblage MP2 was found 40–50 cm lower, in the deposits of horizon 9B under another horizon of humification at the top of the layer. Two determinations were obtained following experimental methodology and using the experimental EPR-method. A sample from the sediments underlying the MP2 layer gave a date of 72.2 ka BP; a date of 62.2 ka BP was obtained for the overlying layer; two radiocarbon dates were obtained from bone for horizon 1: >42 ka BP (AA-8873) and >44 ka BP (AA-8894) (Derevianko, Petrin, Rybin, 2000: 38). According to the stratigraphic data and palynological evidence which has been indirectly confirmed by the EPR dates, the assemblage MP2 may be associated with a period of approx. 60–50 ka BP, that is, with the end of MIS 4 or the beginning of MIS 3. The thickness of the deposits which incorporated horizon MP2, reached 30 cm; the total area was ca 80 m^2; the richest area of finds amounted to about 30 m^2 and was located under the rock (excavation pits No. 1 and 4). The assemblage included about 1500 lithic artifacts. The works on refitting the artifacts from horizon MP2 still continues. The finds represent two main interrelated methods of core reduction. The first method is a simple (non-Levallois) parallel unidirectional reduction of flat cores for producing blades and flakes. The second method is unidirectional convergent Levallois flaking for producing points (the Kara-Bom collection of Levallois points is one of the richest and most impressive collections in the Paleolithic of Northern and Central Asia). A typical version of the Levallois reduction method is exemplified by a small refitted artifact (Fig. 1, *4*), which shows that the point with its faceted striking-platform was formed by weakly convergent unidirectional dèbordant removals and spalls which determined a Y-shaped dorsal pattern and symmetrical, even convergent edges. The ratio of the laminar blanks was 30 %. Subrectangular partings were chosen as core-blanks for producing Levallois spalls. The outline of a Levallois point was formed by marginal and parallel elongated flaking. After detaching the first Levallois point, the flaking-surface and the striking-platform were prepared again and the next Levallois point was detached. Reduction technique and methods of flaking could change at the final stage; for example, parallel reduction of a flat core was applied for producing non-Levallois spalls. This reduction strategy can be seen in a refitted block from layer MP2 (for more details, see (Slavinsky, Rybin, 2007)) (Fig. 1, *1–3*). The artifact which was reconstructed using the refitting method, consisted of 37 elements which were discovered over an area of 6 m^2 (sq. И-К-9, -11). An elongated, slightly flattened subrectangular parting was used as a blank for the core. Its reduction was carried out according to a pre-determined plan. First, the plane of the main striking-platform and the direction of the main knapping-axis for the intended blanks were selected. The axis was oriented along one of the longitudinal ridges of the blank. One of the lateral faces which formed the ridge, had a smooth, even natural surface which later served as a ready lateral face for Levallois blanks without additional trimming (elements No. 14, 17 of the block). The use of the natural surface for forming the Y-shaped pattern of the Levallois blank was a non-standard solution. Two more atypical Levallois points were successively removed after rejuvenation of the lateral faces and the striking-platform (elements No. 20, 21). The reshaping of the platforms and rejuvenation of the core flaking-surface, which were subsequently made, did not produce additional points. On the working-surface, the residual core had negative scars of two flakes which were detached using simple parallel reduction technique.

Variation in the Upper Paleolithic techniques of lithic reduction

The study of archaeological collections from habitation levels 1–6 of excavation pit No. 4 (1876 objects) using petrographic analysis of raw materials and the refitting method made it possible to supplement the collection of stone artifacts from the adjacent excavation pit No. 1 (134 objects). In effect, seventy two groups of artifacts were identified from the entire collection of 2010 objects according to their raw materials, comprising 842 objects or over 40 % of the entire collection. Two hundred ninety four artifacts or about 14 % of the total number of finds constituted elements of the reconstructed reduction process. The positions of the artifacts belonging to different raw material units were determined in the sediments of excavation pit No. 4, which allowed us to clarify the sequence of cultural deposits at the site.

We determined the positions of the artifacts from different groups of raw materials, as well as hearth or combustion structures and large stone slabs on longitudinal and transverse cross-section of the excavation area, which revealed two levels where the

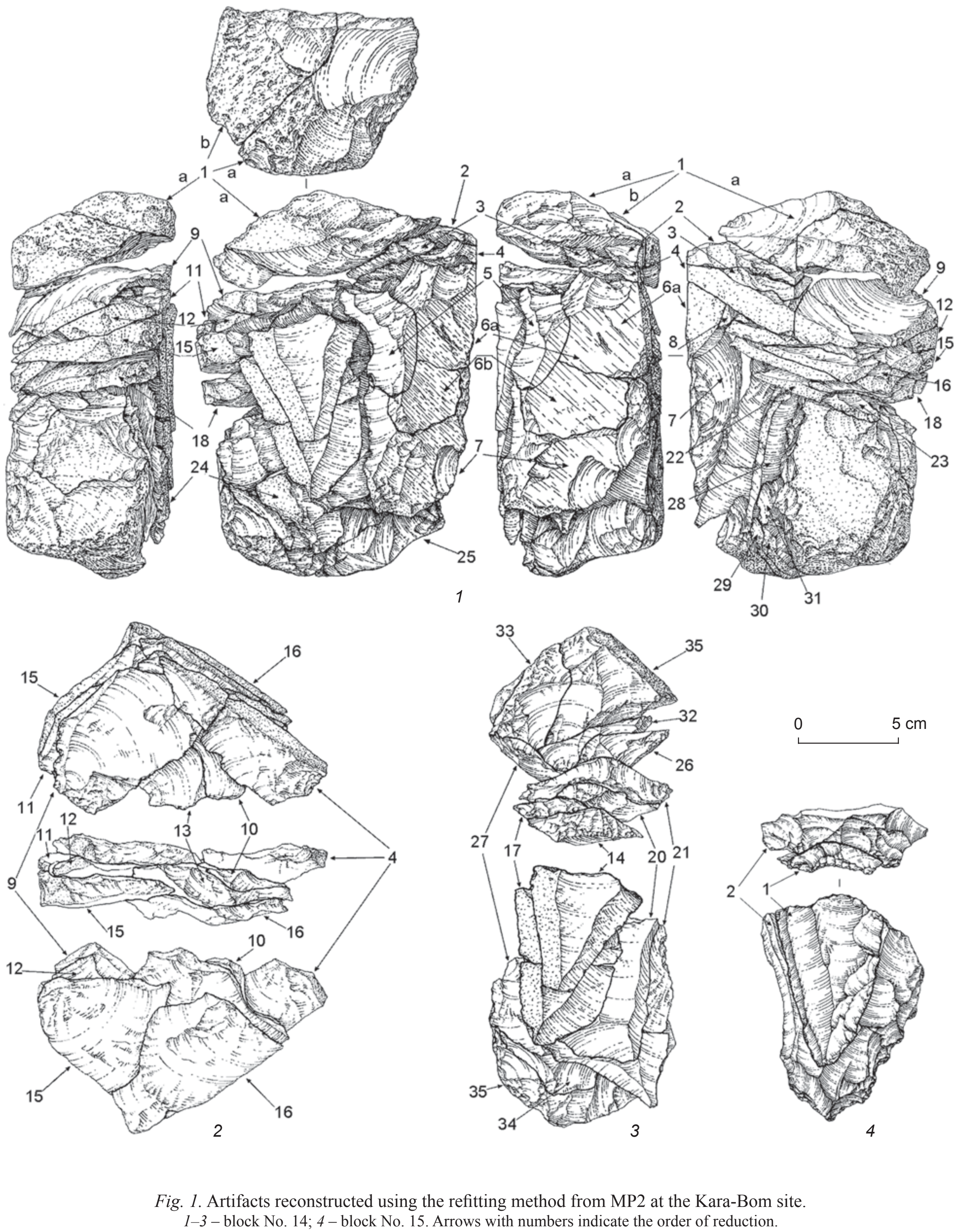

Fig. 1. Artifacts reconstructed using the refitting method from MP2 at the Kara-Bom site.
1–3 – block No. 14; *4* – block No. 15. Arrows with numbers indicate the order of reduction.
1–3 – (Slavinsky, Rybin, 2007: Fig. 1.).

finds were discovered: the cultural horizons UP1 (20 raw material units) and UP2 (52 raw material units) (Belousova, Rybin, 2013). Archaeological materials from the later horizon UP1 occurred in layer 5B; cultural deposits were associated with the following dates, obtained by the ^{14}C: 30,990 ± 460 BP (GX-17,593), 33,780 ± 570 BP (GX-17,594), and 34,180 ± 640 BP (GX-17,595) (Goebel, Derevianko, Petrin, 1993). The top of the lithological layer 6 and the bottom of the lithological layer 5B constituted an intermediate layer between the horizons. The intermediate layer was only relatively sterile; it tapered down a hill, where the cultural deposits of the two horizons came into partial contact. Materials of the horizon UP2 were located in the central part or the bottom of lithological layer 6. Horizon UP2 is associated with the ^{14}C dates of 43,200 ± 1500 BP (GX-17,597) and 43,300 ± 1600 BP (GX-17,596). Since excavation pits No. 4 and 1 were protected by a barrier of rock from the north and northeast, they were not subjected to the full impact of destructive conditions (Derevianko et al., 1998). However, the analysis of artifact distribution has showed that slope processes caused a disturbance in the deposits of the later horizon UP1 and a significant shift of cultural remains down the slope (the inclination angle of the surface where the finds occurred, was about 25°). The near-horizontal sediments of horizon UP2 underwent minimal displacement along the slope (the inclination angle of the surface where the finds occurred, was 5–10°) (Fig. 2).

According to our data, lithic artifacts which had been previously correlated with the habitation levels 1–3 may be viewed as constituent parts of a single horizon UP1, while most of the finds from the habitation levels 5 and 6 must have belonged to a single horizon UP2. During the excavations, habitation level 4 was primarily associated with finds occurring between horizons UP1 and UP2.

Forty refits consisting of two to ten objects, have been assembled using the artifacts from the cultural horizon UP2 (1100 objects). Depths, where these elements occurred, constitute a single level of finds; the dip of the slope ranged from –290 cm along line 5 to –339 cm along line 8. The analysis of the locations on the plan of the excavations, where the elements of the largest blocks were found, revealed two concentration zones: the first zone of apparently somewhat elongated shape was located in sq. З-И-5, and -6 (the elements of one block were found in sq. З-8) (Fig. 3); the second zone was located in sq. З-И-8.

The refitted artifacts from the horizon under discussion represented two reduction technologies:

1. *Subprismatic bidirectional method for producing medium-sized and large blades*. We shall discuss six refitted blocks. Each one was composed of several elements including cores (Fig. 4; 5, *1*, *4*). The refitted artifacts belong to the middle and final stages in the process of producing main blanks. The cores have subcylindrical elongated shapes; weakly-slanted platforms (knapping angle >75°) were formed on their opposite ends by transverse removals. The blanks were formed by flaking from opposite directions, which depended on the size and shape of the substrate at each particular flaking stage. These were blades of medium size, less frequently of large size, sometimes of pointed shape (see Fig. 4, *4*). As a rule, their dorsal surfaces show negative scars of subparallel bidirectional removals.

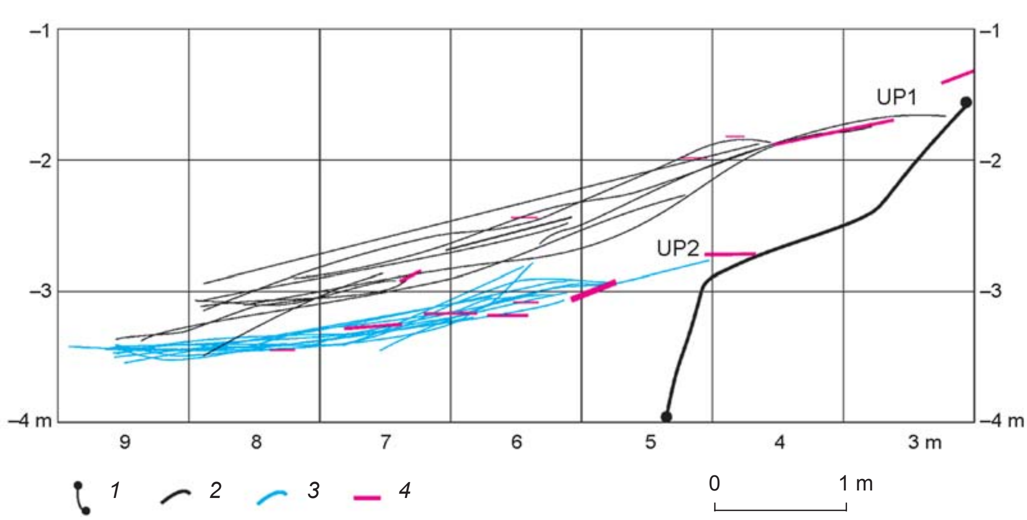

Fig. 2. Planigraphic links recovered by the refitting method and petrographic features of the artifacts in the longitudinal profile of excavation pit No. 4 (along sq. 3) at the Kara-Bom site.
1 – vertical profile of rock along the line 3; *2* – distribution of artifacts made from various groups of raw materials in UP1; *3* – distribution of artifacts made from various groups of raw materials of UP2; *4* – distribution of combustion structures.

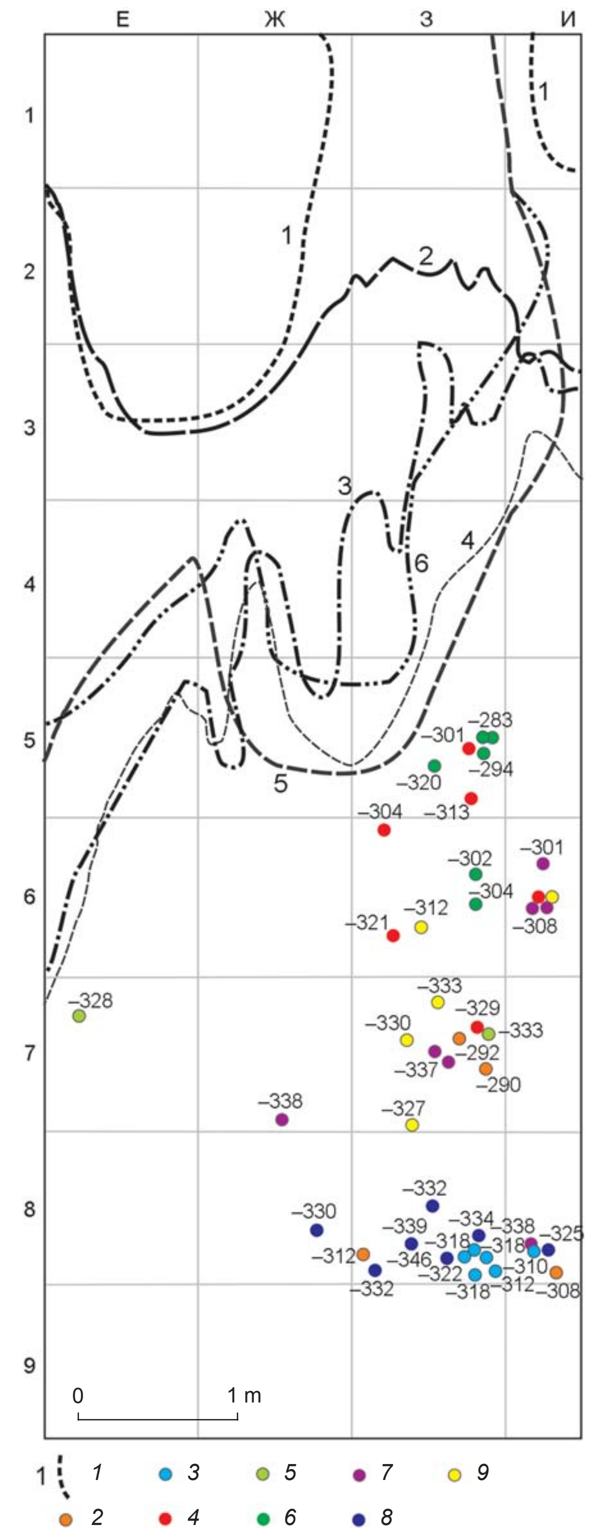

Fig. 3. Distribution of refitted artifacts in a section of excavation pit No. 4 at the Kara-Bom site.
1 – the line of rock outcrop at the stage of unearthing individual habitation levels; *2* – block No. 12; *3* – block No. 13; *4* – block No. 1; *5* – block No. 4; *6* – block No. 5; *7* – blocks No. 6 and 7; *8* – block No. 8; *9* – block No. 9.
2, *3* – UP1; *4*–*9* – UP2.

Refitting data indicate the use of two methods of flaking in subprismatic bidirectional technology. The first method involved crested trimming of lateral faces of the core (see Fig. 4, *4*; 5, *1*). During the reduction of the core, sharp lateral ridges were treated with a series of removals directed perpendicular to the longitudinal axis of the frontal surface towards the working plane and away from the working plane. The formation of the optimal convexity of the flaking-surface was completed by longitudinal detachment of lateral ridges (in the form of semi-crested and crested blades). After that, the main blades were produced. If the processed ridges were not located on the lateral faces of the core, the longitudinal ridges were formed by technical removals directed perpendicular to the longitudinal axis of the core frontal-surface. After producing a marginal crested or semi-crested blade, flakes were removed along the formed ridges, and then, after intense trimming of the striking-platform, the adjacent plane was subjected to sequential knapping (see Fig. 4, *1*). For partial decortication of the surface, the longitudinal ridge was removed from the core that had prismatic shape and a flaking-surface around the entire perimeter (see Fig. 4, *5*). This refitted artifact is one of the earliest examples showing the use of prismatic technology in Northern and Central Asia.

The second method of flaking is manifested by refitted artifacts which do not show signs of transverse lateral trimming. The object No. 3 (see Fig. 4, *2*) shows traces of sequential knapping of blades from the opposing striking-platforms. The reconstructed block No. 5 is a perfect illustration of changes in the methods of lithic reduction, which took place at the beginning of the Upper Paleolithic (see Fig. 4, *3*). According to the patterns of negative scars, in the process of reduction the flat working-surface of the core acquired an outline which was typical of the Levallois convergent technique. However, the reduction technology was non-Levallois. Splitting was carried out using bidirectional removals. After the series of spall detachments, an unsuccessful attempt to form a flaking-surface of optimal convexity on the narrow side of the core was made. This is revealed by negative scars of small laminar detachments which formed hinge fracture in an attempt to remove the lateral longitudinal ridge.

One of the refitted artifacts shows signs of reusing the residual core for producing laminar blanks from its narrow face (see Fig. 5, *4*).

2. *Narrow-faced method for producing small laminar blanks* (see Fig. 5, *2*, *3*, *5*–*8*). This is a specific method of lithic reduction. Large and massive blades, marginal blades or flakes, or residual cores produced using subprismatic laminar technology, were reused as blanks for narrow-faced cores. The refitted artifacts illustrate the process of narrow-faced unidirectional (see Fig. 5,

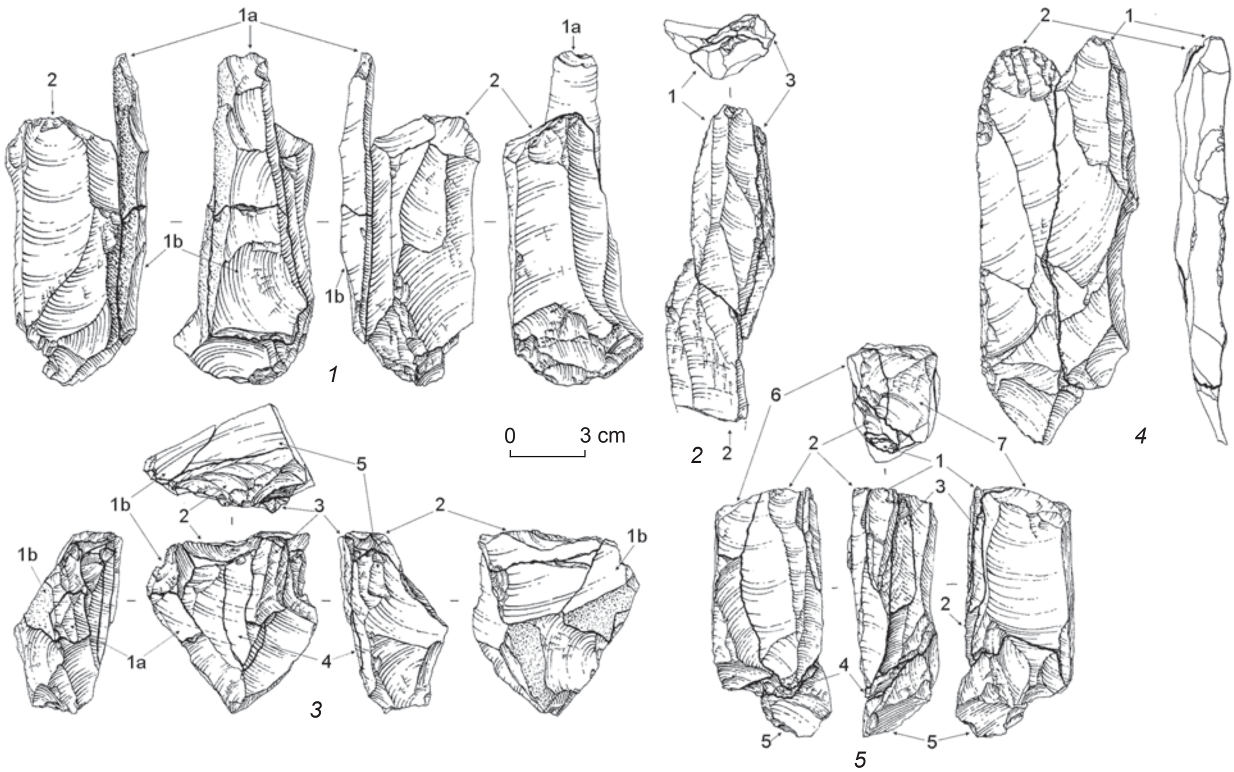

Fig. 4. Refitted artifacts No. 1 (*5*), 2 (*1*), 3 (*2*), 4 (*4*), 5 (*3*) from UP2 at the Kara-Bom site.

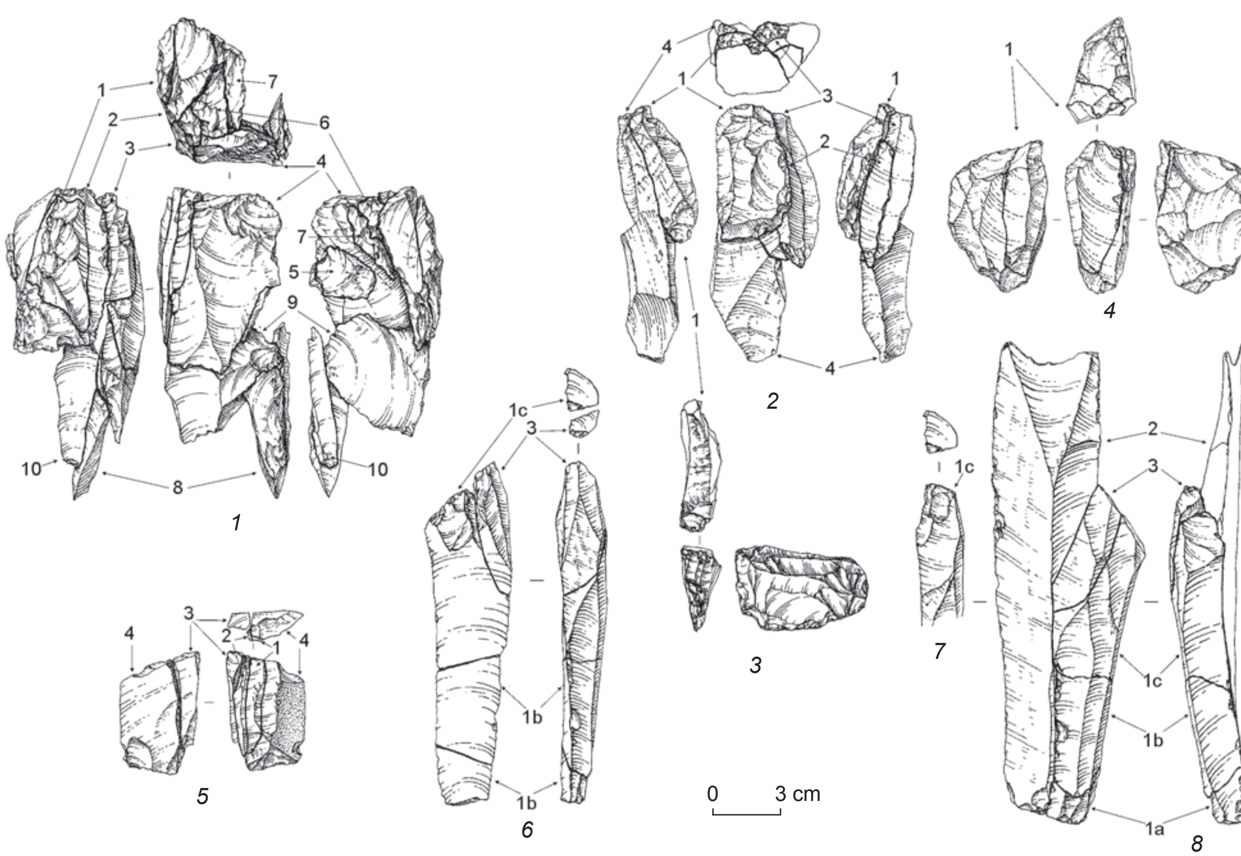

Fig. 5. Refitted artifacts No. 6 (*1*), 7 (*4*), 8 (*6–8*), 9 (*2*, *3*), 10 (*5*) from UP2 at the Kara-Bom site.

2, *3*, *5–8*) and bidirectional (see Fig. 5, *5*) removal of small laminar blanks, triangular or trapezoidal in cross-section (with the ratio of thickness to width <1 : 2). Residual narrow-faced cores on thick laminar blanks and dèbordants were found in great numbers in the cultural horizon UP2. Such cores resemble multifaceted burins, and this is why in a number of studies they were described as cores of a specific type—burin-cores (Petrin, Rybin, 2001; Zwyns et al., 2012).

The refitted object No. 9 (see Fig. 5, *2*, *3*) deserves a special attention in this regard. The original reduction was carried out following the system which was typical of subprismatic bidirectional producing of medium-sized blades. A working-surface with negative scars of microblades was formed on a massive marginal spall (removal 1) after its separation from the core. The core rear was retouched. According to its morphology, the object is very similar to wedge-shaped cores, common for the later stage of the Paleolithic in Northern Asia.

Six cojoinings, which comprised from three to nine elements, were refitted in the collection of the cultural horizon UP1 from excavation pit No. 4 (264 objects) (Fig. 6). Two working-grounds operated during the emergence of this cultural horizon. After the partial destruction of the upper ground, its cultural deposits gradually covered the lower ground. Artifact depths, where the elements of the refitted blocks occurred, constitute a single level; the dip of the slope ranged from –290 cm along line 7 to –322 cm along line 8. The elements of the refittings were concentrated in sq. З-7 and З-8 (see Fig. 3).

The refitted artifacts associated with the UP1, testify to the use of two reduction methods:

The first was *the subprismatic bidirectional method for producing medium-sized and large blades*. The blocks belong to the initial (see Fig. 6, *2*) and terminal (see Fig. 6, *1*) stages of the reduction process. Blanks were produced by bidirectional reduction depending on the size and shape of the substrate at each particular flaking stage. These are blades of medium and large size. Spalls have subparallel edges; the dorsal surface usually shows negative scars of subparallel bidirectional removals.

Two applications of this method were found. The first version implied the formation of a longitudinal

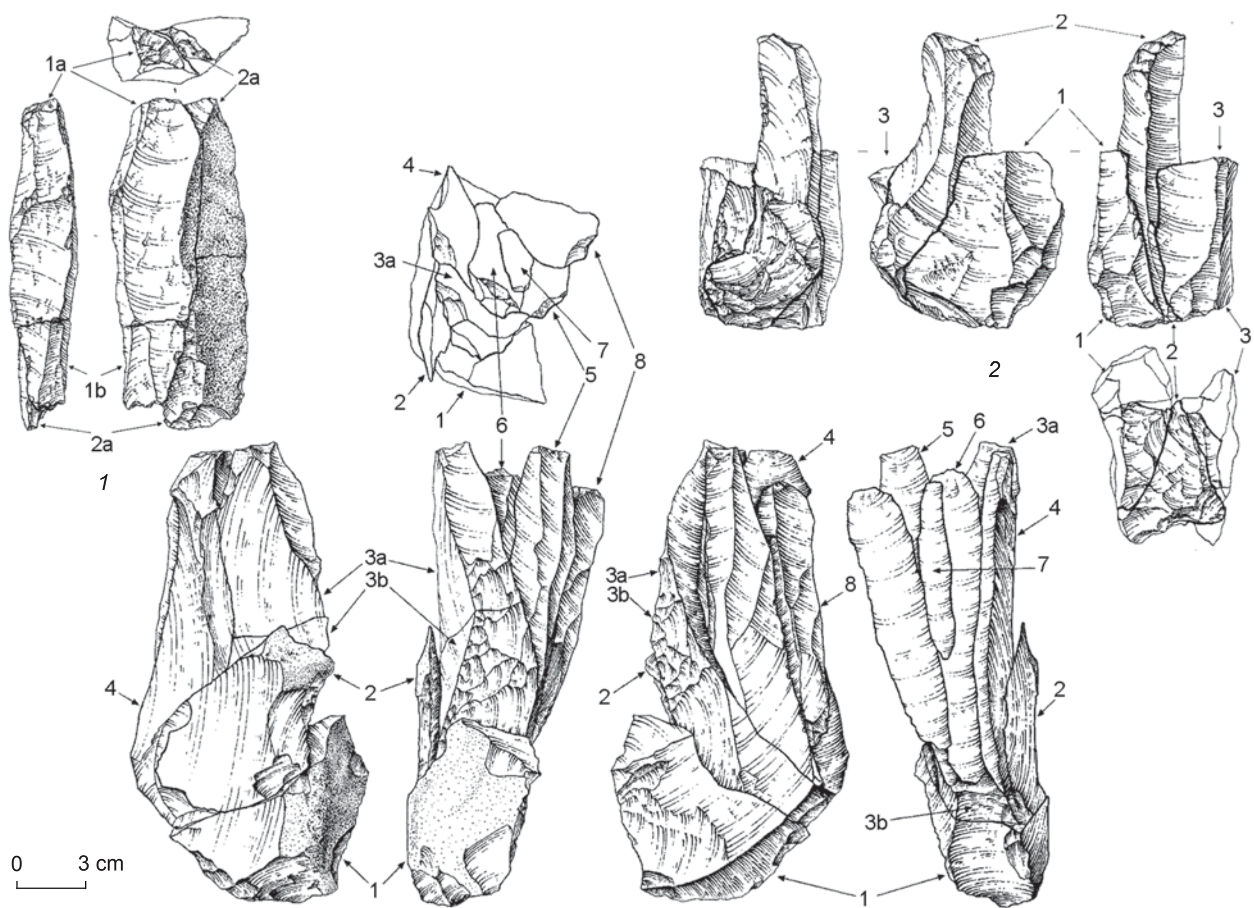

Fig. 6. Refitted artifacts No. 11 (*2*), 12 (*1*), 13 (*3*) from UP1 at the Kara-Bom site.
3 – after (Slavinsky, Rybin, 2007: 76, fig. 4).

ridge on the rear side of a subprismatic core through transverse removals (Fig. 6, *2*). The second version is represented by conjoining marginal blades. They were produced from a single striking-platform and do not show traces of any additional trimming of the core front (Fig. 6, *1*). It should be noted that both refits were made from raw material of relatively low quality with internal fractures.

The second was *the subprismatic unidirectional method for producing medium-sized and large blades using the technique of initial crested spalls*. The refitted artifact, which represents this method, consists of nine elements (Fig. 6, *3*) and is associated with the initial and middle stages of parallel longitudinal reduction of large laminar blanks with a thin elongated narrow-faced working-surface. Careful crested processing of the longitudinal frontal ridge was carried out after removing the longitudinal ridge of the narrow-faced part of the core. The terminal part of the object was gradually narrowed as a result of removing technical spalls. Judging by the refitted block, at least ten blades of standard morphology were produced after the preparation of the working-surface.

Discussion

Our investigation has revealed significant differences between the lithic technologies which were used at the Kara-Bom site in the Middle Paleolithic and in the initial Upper Paleolithic. According to the results of refitting and the analysis of blank assemblages, unidirectional parallel and unidirectional convergent Levallois technologies were widely used in the Middle Paleolithic industry MP2. The method of Levallois convergent unidirectional reduction which is represented by two refitted blocks, was used for producing points of similar sizes from a single core surface through repeated trimmings by technical marginal flaking after detachment of each blank. These technical spalls determined the Y-shaped unidirectional dorsal pattern of the point's surface. Faceted striking-platforms were formed by trimming spalls. There were usually not more than two main blanks produced in one cycle. Knapping was made from the wide surface of the core. However, if the original blank had a rectangular shape, marginal flakes could expand to the side faces of the core.

The assemblage UP2 revealed some fundamental differences from the underlying assemblage MP2. These differences were primarily caused by wide use of volumetric subprismatic and prismatic reduction instead of predominantly laminar reduction. The method of detachment, typical of the Upper Paleolithic technologies, implied the shift of the flaking-surface from the lateral narrow face of the core to the wide face and back. The method of trimming core lateral faces by marginal spalls was used for maintaining volume both in the Middle and Upper Paleolithic at Kara-Bom, but the methods for preparing lateral faces were different. As a rule, in the Middle Paleolithic, lateral faces were not specifically shaped. In the Upper Paleolithic assemblages, there is some evidence for regular trimming of lateral faces by transverse flaking. The presence of crested blades indicates the creation of a ridge not only on the lateral face of the core, but also on other parts of the flaking-surface.

The assemblages of the initial Upper Paleolithic at Kara-Bom suggest the predominance of bidirectional reduction. According to the assemblage MP2, this method was rarely used in the earlier period. Primary reduction of cores from horizon UP2 is characterized by alternating flaking from opposing striking-platforms, which resulted in the production of blades and pointed spalls, resembling Levallois points according to their morphology. The proportions of these spalls depended on the form of the core and the stage of core reduction rather than on intentional preparation. The lithic reduction methods which we reconstructed by refitting, also appear in the assemblage of laminar flakes. As it was shown above, two prevailing groups of blades can be quantitatively identified in the assemblage UP2 at Kara-Bom. The first group includes objects varying in width from 5 to 12 mm; the second group from 20 to 30 mm (Zwyns et al., 2012). It is clear that the first group of artifacts (bladelets) were obtained by reduction of narrow-faced cores (burin-cores), while the objects of the second group are associated with subprismatic reduction. The use of bidirectional processing which produced pointed spalls, is found in the earliest assemblages of the initial Upper Paleolithic of the Levant, in levels 1 and 2 of the Boker Tachtit site. Exactly as at Kara-Bom, these levels contain cores with asymmetrical reduction and alternating removals from the narrow and wide sides of the core (Škrdla, 2003b).

Comparison of lithic reduction methods in the periods corresponding to cultural horizons UP1 and UP2, on the basis of refitting data, has revealed that the technique of subprismatic bidirectional detachment of medium-sized and large laminar blanks was determinative for the industries of both horizons. The use of the subprismatic unidirectional technique was found only in the industry of cultural horizon UP1. For producing blades at each habitation event at the site, ancient artisans formed the longitudinal ridge by removals which were transverse to the axis of knapping; however, such treatment had different purposes. The refitted artifacts from the assemblage UP1 have shown that the longitudinal ridge was created either on the rear (probably for maintaining the shape and volume), or on the central part of the future working-surface, for the subsequent reduction by the method of crested flaking. The refits from the assemblage UP2 indicate that both lateral faces of the core could be treated with a series of transverse removals, but often while creating the longitudinal ridge, the artisan was guided by the given situation. The use of narrow-faced technology for producing small laminar blanks is attested to only on the basis of refits from the assemblage UP2.

Unidirectional convergent technology reached its highest development in the second half of MIS 4 and in the early MIS 3. This is indicated by the industries of the Late Middle Paleolithic MP2 at Kara-Bom, layers 5 and 4 in Ust-Kan Cave, which are successive to the assemblages from the middle portion of the profile of Denisova Cave and layers 14 and 18 of Ust-Karakol-1. These assemblages manifest a similar tool set and almost identical reduction technique which was typical of the so-called Kara-Bom type of the Middle Paleolithic in the Altai Mountains. It is possible that the industries corresponding to MIS 4 and MIS 3 (from 70 ka to 48–45 ka BP) may be regarded as their closest parallels in technological terms, although they were very remote geographically. Assemblages from layers X and IX of Kebara Cave in Israel (Meignen, Bar-Yosef, 2004; Demidenko, 2011) are the benchmark for this technocomplex. These industries, which are considered an integral part of the Late Levantine Mousterian entity (Tabun B assemblage), typically show: 1) core preparation associated with careful faceting of the striking-platform; and 2) the process of core reduction, combining removal of elongated marginal spalls and flakes covered with natural cortex, for production of blades—preparatory spalls for manufacturing Levallois points.

The technology of blade production following the subprismatic bidirectional method, which can be traced by refitted objects associated with layer UP2 of the Kara-Bom site, appears in a number of assemblages in the Altai Mountains corresponding to the first half of MIS 3. Expressive evidence for the use of such technology was discovered at the Kara-Tenesh site (Derevianko et al., 1999), in the industries of layer 5 in the excavation area of 1986, in layers 8–11 in the excavation area of 1993–1997 at the site of Ust-Karakol-1 (Slavinsky, 2007; Prirodnaya sreda…, 2003), in the industries from layers 10–12 at the site of Anui 3 (Derevianko, Shunkov, 2004), and in the materials from layer 7 of the entrance zone of Denisova Cave (Ibid.).

The emergence of the technology for producing burin-cores was attested to in the earliest Upper Paleolithic horizon MP1 at the Kara-Bom site (Derevianko et al., 1998). The narrow-faced technique for producing small laminar blanks in the form of burin-cores or narrow-faced cores on slabs can be found in cultural deposits of almost every site mentioned above, including the earliest Upper Paleolithic deposits of layer 11 in the East Gallery of Denisova Cave (Derevianko et al., 2010).

The industries of the eastern part of Southern Siberia and Mongolia, namely the sites of Khotyk, Kamenka, and Tolbor 16, represent the set of reduction methods, typical of the Kara-Bom industry of the initial Upper Paleolithic (Lbova, 2000; Zwyns et al., 2014). The operating sequence of lithic reduction in the period corresponding to horizons 5 and 6 at the site of Tolbor 4 in Northern Mongolia, dated to 35–41 ka BP, was virtually the same as the Kara-Bom technology of the initial Upper Paleolithic. The industry of Tolbor 4 includes one of the largest series of typical burin-cores found outside the Altai Mountains (Derevianko et al., 2007).

Conclusions

The culture-bearing horizons of Kara-Bom may manifest at least four habitation stages at the site, separated by chronological gaps of several thousands of years. Although individual cultural horizons did not not contain microlevels, we can assume that these cycles were associated with the repeated visits of humans to the site. These horizons are stratigraphically indivisible by taphonomic criteria. In addition, this small area was the place of intensive activities of human groups, which reached their maximum at the time of horizon UP2. These activities, associated with various habitation events, resulted in overlapping of the deposits.

Our data do not give grounds for confirming direct cultural continuity between the Middle and Upper Paleolithic assemblages which manifest substantially different methods of core reduction. However, it is logical to assume that laminar and parallel reduction as well as convergent unidirectional reduction, typical of the Middle Paleolithic in the region, constituted the basis for the emergence of the subprismatic bidirectional reduction technology of the initial Upper Paleolithic in the Altai Mountains. The small assemblage MP1 of Kara-Bom, isolated by sterile strata and occupying an intermediate position between the Middle and Upper Paleolithic both in stratigraphic and technological terms, may indirectly testify to the possible emergence of the industry of the initial Upper Paleolithic in Kara-Bom on a local basis. This assemblage shows a sharp increase in the share of blades and decrease in the share of faceted striking-platforms, compared to the underlying MP2. Along with Levallois points, flakes, and cores for producing Levallois flakes, MP1 contained a backed bladelet, two burin-cores, and a symmetric retouched point on a blade-blank, typical of the Upper Paleolithic in the Altai Mountains (Derevianko et al., 1998). We can speak in more definitive terms about the continuity between the assemblages of the initial Upper Paleolithic (UP2) and the Early Upper Paleolithic (UP1) of Kara-Bom, which show a typical method of reduction; the only exception may be the lack of technology for producing burin-cores in the assemblage of UP1. The Bohunician and the Emiran in the regional sequences of Central and Eastern Europe and the Levant were being replaced by a substantially different technocomplexes of the Aurignacian and the Ahmarian. The analysis of the industries belonging to the initial Upper Paleolithic of the Altai Mountains does not make it possible to make a conclusion about a rapid replacement of these traditions by a particular technological version of the Early Upper Paleolithic tradition.

The earliest Upper Paleolithic assemblages (their age exceeds 35 ka BP) in the Trans-Baikal region, the Altai Mountains, and Mongolia—the regions in the northern and eastern parts of the Central Asia—manifest a clear predominance of the Kara-Bom type of lithic reduction. This suggests that reduction methods which we have reconstructed by refitting the materials from the assemblage UP2 at Kara-Bom, were typical of the technocomplex associated exactly with the initial Upper Paleolithic.

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