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Bladelet industries of the Early Upper Palaeolithic in southern Kazakhstan: A detailed analysis of carinated bladelet cores excavated from the newly discovered Buiryokbastau-Bulak-1 site in the Karatau mountains

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A R T I C L E I N F O

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A B S T R A C T

Kazakhstan, which connects the Altai mountains and Caucasus area of Uzbekistan, is an indispensable region in arguments about the diffusion and settlement of *Homo sapiens* in Asia. Upper Palaeolithic culture in eastern Kazakhstan and the northern Altai developed together. Nevertheless, reliable chronologic data from archaeological sites in these regions, necessary for understanding diffusion of *Homo sapiens*, are rare. The goal of this paper is to evaluate the Early Upper Palaeolithic (EUP) culture in southern Kazakhstan through detailed analysis of materials from the Buiryokbastau-Bulak-1 site (N43°06′36.24″, E70°34′03.70″). This is a site that was newly-discovered during survey in the Karatau mountains, at which two clear cultural layers were identified during excavations in 2018 and 2019. Although these two cultural layers consist of alluvial deposits formed by fluvial erosion of a hilly slope, their stratigraphic distribution was orderly and they likely remain in their original depositional positions. Material from the lower cultural layer, including carinated bladelet cores, medium-sized blade cores, and end/side scrapers on medium-sized blades, provides the data for this analysis. Statistical analysis of the bladelet cores indicates that the size and shape of bladelets from the cores of the Buiryokbastau-Bulak-1 site were very similar to those from the Shugnou site in Tajikistan. Similarly, six types of bladelet cores are common at both the Buiryokbastau-Bulak-1 site and at sites in Tajikistan and Uzbekistan, especially the Shugnou site in Tajikistan. Therefore, the lower cultural layer appears to be an assemblage contemporaneous with the Early Upper Palaeolithic period in western Central Asia and related to the Kulbulakian tradition in which bladelet production predominated. The lower cultural layer at the Buiryokbastau-Bulak-1 site is a valuable example of Kulbulakian tradition industry in Kazakhstan territory, making it critical in assessing the structure of lithic industries during the EUP period in western Central Asia and in understanding how modern humans adapted to the central portions of Eurasia.

1. Introduction

Kazakhstan is a crucial region for exploring the pathways and adaptations that accompanied the migration of *Homo sapiens* into Asia. In addition the area from the northern foothills of the Tien Shan mountain range to the eastern foothills of the Karatau mountains is important for determining how aspects of Palaeolithic culture in western Central Asia developed in this intermediary region (Fig. 1). For example, it has been proposed that the Kulbulakian tradition developed a unique bladelet production technique (Kolobova et al., 2014) in the Early Upper Palaeolithic period (EUP period, 40-30 ka BP).

Significantly, favorable loess deposits have been found in the region, increasing the likelihood of multi-layer site formation (Yun et al., 2015). Despite these factors, few stratigraphic Upper Palaeolithic sites have been discovered during excavation surveys of the region. The goal of this paper is to evaluate the EUP culture in the south of Kazakhstan through detailed analysis of new materials from the Buiryokbastau-Bulak (БуйрЁкбастау-Булак)-1 site (Fig. 2). We provide an evaluation and reconstruction of the recovered bladelet industries based on materials derived from the EUP. We find a high level of consistency between the Buiryokbastau-Bulak-1 site lithics and known relevant materials from the southern half of western Central Asia, enabling us to place our finds into a wider regional context.

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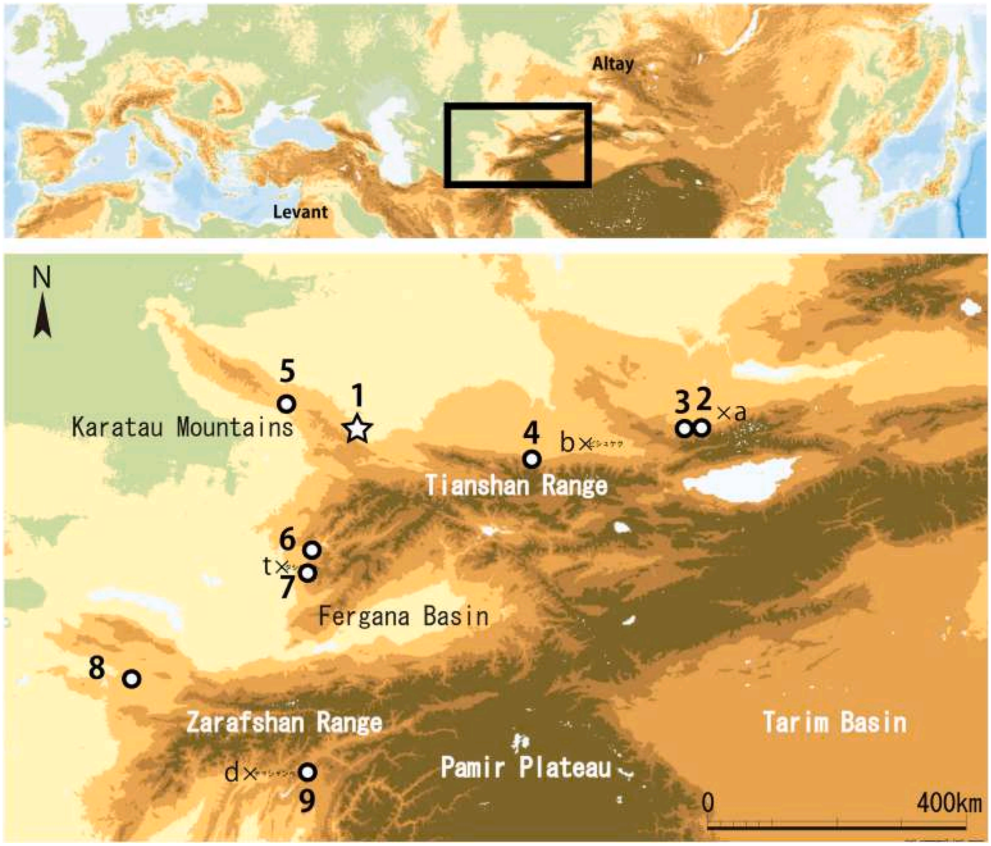

Fig. 1. The distribution of the EUP sites in western Central Asia (1 ~ 9: archaeological sites, a ~ d: modern cities). 【1: Buiryokbastau-Bulak-1, 2: Maibulak, 3: Kyzylauz −2 (the above are Kazakhstan) , Kurama (Kyrgyz) , 5:C. Valikhanov (Kazakhstan, 6: Dodekatum-2, 7: Kulbulak, 8: Samarkand (the above are Uzbekistan) , 9: Shugnou (Tajikistan) , a: Almaty, b: Bishkek, t:Tashkent, d: Dushanbe】.

2. Analytical background and methods

We undertook excavations at the newly discovered Buiryokbastau-Bulak-1 site, where artifacts possibly belonging to the EUP period had been detected during a general survey in 2017 (Kunitake, Taimaganbetov, 2018) (Fig. 1). The stone tools which were available from these excavations were bladelet cores and microblade cores. From the materials found in this archaeological excavation with wet-sieving, the bladelet cores were selected for analysis, and statistical analysis (software; JMP v8.0.2 of Statical Discovery SAS) using one-way analysis of variance to determine whether the size and form of the detached bladelets had similarities with materials found in other archaeological excavations at sites in western Central Asia. The bladelet core types were typologically classified. Comparison was again made with materials recovered from elsewhere in western Central Asia, to compare the production techniques used in the region.

Fig. 2. The general view of the Buiryokbastau-Bulak-1 site (from the northeast).

3. Materials

3.1. Excavation background

Although there are more than 50 known sites with Upper

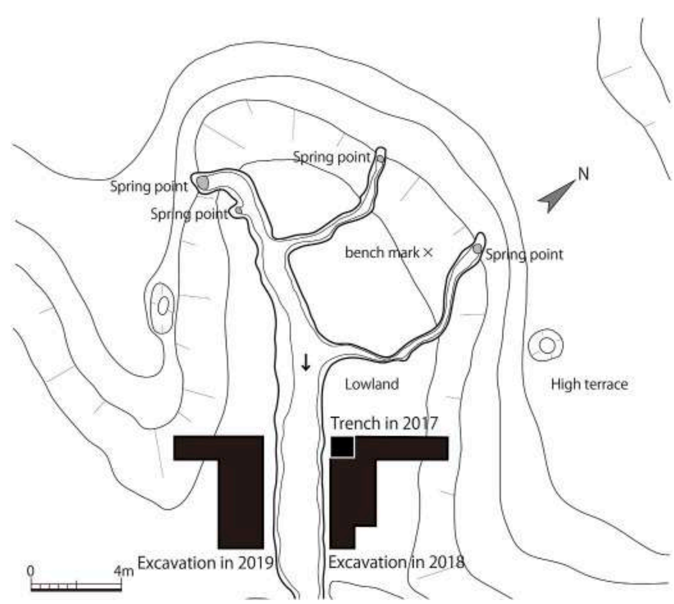

Fig. 3. The excavation plan of the Buiryokbastau-Bulak-1 site (2017–2019).

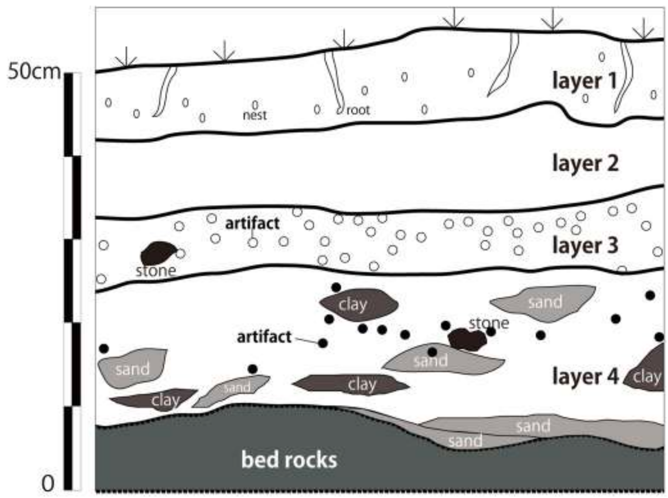

Fig. 4. The stratigraphic section and cultural layers of the Buiryokbastau-Bulak-1 site.

(the southern section of excavation in 2018; ○:the upper cultural layer, ●:the lower cultural layer)

Palaeolithic technologies known in Kazakhstan, the majority represent surface scatters and only 9 sites have been found with intact, stratified cultural layers containing Upper Palaeolithic lithics (Kunitake 2019a). Among those stratified sites, Rakhat (Ozherelyev et al., 2019), which is under excavation, and Maibulak (Taimagambetov, Ozherelyev, 2009), where three cultural layers are recognized, are situated the northern foothills of the Tien Shan mountains. Recently, Ushbulak-1 (Shunkov et al., 2017) has been argued to contain an Initial Upper Palaeolithic assemblage in eastern Kazakhstan. Nevertheless, the chronology and nature of the Upper Palaeolithic in the south of Kazakhstan has remained poorly investigated. the lack of consistency in materials and data on stratified transitions remains a major impediment. Furthermore, the geoarchaeological framework in three geomorphic and sedimentary archives; karst, loess, and spring deposits, have been noted, and more detailed fieldwork are recommended for future work in this area (Iovita et al., 2020).

For these reasons, a general survey was conducted in October 2017 in the eastern foothills of the Karatau mountains with the goal of discovering Upper Palaeolithic stratified deposits. A new site, Buiryokbastau-Bulak-1, was found in the eastern hilly area at the foot of the mountains during the survey (Kunitake, Taimagambetov, 2018). A test excavation was carried out in November 2017, revealing a stratified layer containing stone tools. Subsequently, full excavations were then carried out at the site in July 2018 and 2019.

The site is located on the edge of a plateau in the eastern hilly area at the foot of the Karatau mountains (Figs. 1 and 2). The elevation is 465m a. s. l., and the coordinates are 43°06′36.24″ N, 70°34′03.70″ E. The name of this site means "terrain with steps similar to a place where spring water originates" in the Kazakh language and, just as this name suggests, the fairly steep slope of the hills flattens out in this area and a large spring can be observed. Many stone tools were scattered on and around the bottom of the stream which flows from the spring.

The site is intersected by the stream which has eroded down through a hilly slope to leave flat areas skirted by elevated ridges on either site of the watercourse (Fig. 3), a difference in elevation between the flat bank edges and the surrounding ridges is approximately 2 m. For the excavations carried out in 2018 and 2019, the flat land along the two banks of the stream was excavated. Two locations in the lower elevation area were selected (Fig. 3). At a distance approximately 10 m downstream from the point where the stream flows from the spring. Excavations targeted the left bank in 2018 and the right bank in 2019. The total area excavated in the two seasons was 24.3 m^2. A 1m grid was set up in the survey area, and the excavation was carried out carefully layer by layer. Artifacts discovered in each stratum had their position and depths recorded.

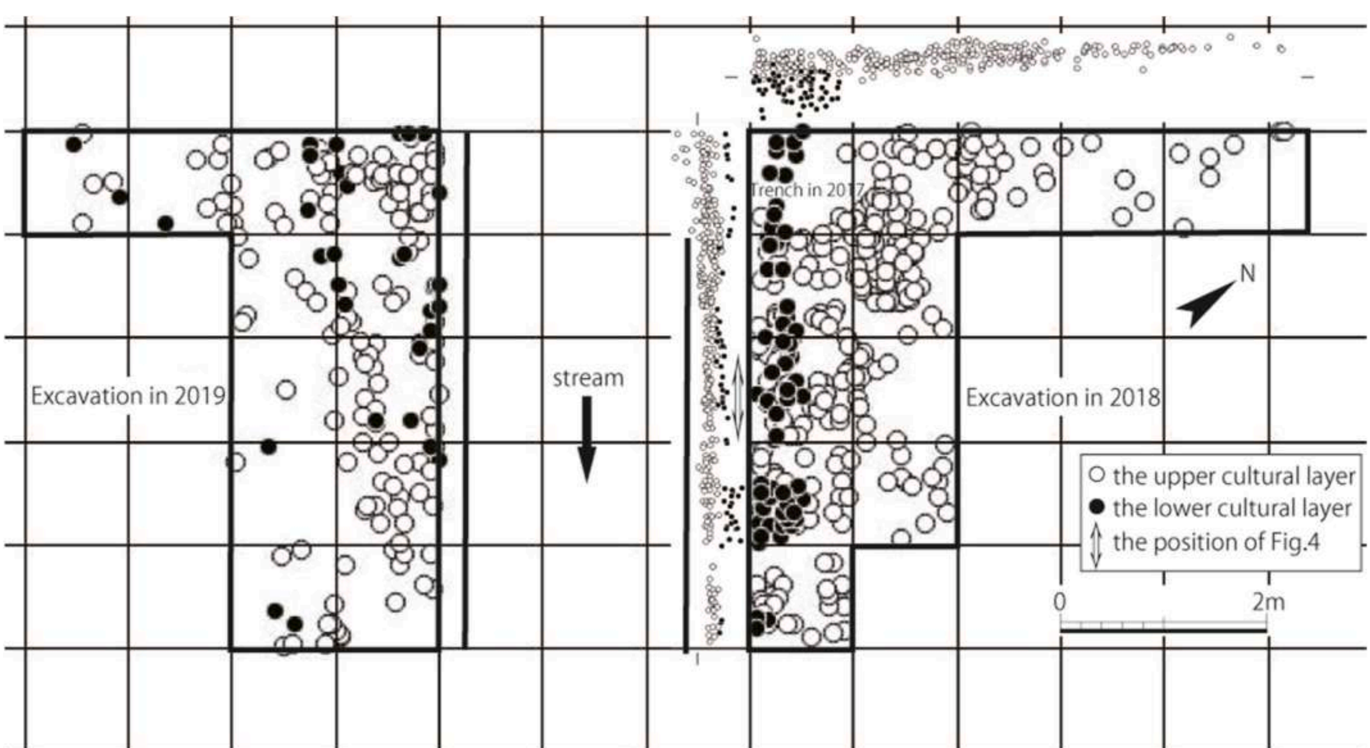

Fig. 5. The horizontal distribution of artifacts in 2018 and 2019 excavation and the vertical distribution of artifacts in 2018 excavation of the Buiryokbastau-Bulak-1 site.

Table 1
The composition of the lithic industry of the upper cultural layer (number from wet-sieving).

	point	end-scraper	side-scraper	notched tool	drill	burin	Pièces esquillées	utilized flake	biface	retouched flake	flake	pebble tool	microblade core	core	other	Grand total
Excavation in 2018																
black shale		9	15 (3)					5		5	31 (14)			10		75 (17)
black flint	3	24	44 (18)	1	2	1	1	9	1	18 (6)	37 (18)		2	11		154 (42)
quartzite			2								1			1		4
chert												1				1
sand stone											3					3
hornfels										1	1	1				3
agate											1					1
ocher															2	2
total	**3**	**33**	**61(21)**	**1**	**2**	**1**	**1**	**14**	**1**	**24(6)**	**74(32)**	**2**	**2**	**22**	**2**	**243(59)**
Excavation in 2019																
black shale		12	13		1			1			17 (7)			12		56 (7)
black flint		15	16 (4)		2		1			7 (3)	8 (4)			3		52 (11)
quartzite											5					5
chert		1	1							1						3
hornfels														1		1
agate											2					2
total		**28**	**30(4)**		**3**		**1**	**1**		**8**	**32(11)**			**16**		**119(18)**
Grand total	**3**	**61**	**91(25)**	**1**	**5**	**1**	**2**	**15**	**1**	**32(9)**	**106(43)**	**2**	**2**	**38**	**2**	**362(77)**

4. Results of the excavations

4.1. Stratigraphy

The basic stratigraphy can be broadly classified into 4 strata (Fig. 4). The full depth of the deposition is 40–50 cm. The layers consisted of the following. Layer 1: blackish brown soil (about 5–10 cm), traces of roots and nests of insects were observed, containing pieces of steel and glass, layer 2: redeposited loess soil (about 5–10 cm), consisted of little blocks (maximum 2 cm) of coarse loess soil, and contained no artifacts, layer 3: dark brown coarse sand (about 10–15 cm), contained stone tools and fragments of bones, and layer 4: dark brown silt soil (about 15–30 cm), consisted of dark brown clay and gray coarse sand. The gray coarse sand was particularly dominant on top of the weathered rhyolite bedrock. The whole of layer 4 contained stone tools and little fragments of bones. These sediment layers were deposited on a base of gray-white rhyolite rock approximately 40–50 cm below the surface. The 2nd layer of sandy soil containing loess appears to have been redeposited from the higher elevation area. The 3rd and 4th layers appear to be the result of stream deposition and, since the boundaries involve straight lines, the 3rd layer was probably deposited by a strong current flattening the 4th layer. The bedrock had numerous east-west cracks, and the 4th layer was deposited between them. In addition, weathered soil consisting of bedrock rhyolites was deposited in the cavities of the bedrock in places.

As noted, artifacts were recovered from the 3rd layer and 4th layer. Although the 3rd layer was found to have a consistent thickness (about 10–15 cm) in both excavations, the 4th layer became thicker closer to the stream. While bedrock was only observed in areas close to the stream during the 2018 excavation of the left bank, it was found throughout the entire excavated area in the 2019 excavation of the right bank.

4.2. Cultural layers and excavated artifacts

The artifacts were classified into two cultural layers based on the stratum of excavation and vertical distribution (Fig. 5). The artifacts recovered from the 3rd layer are referred to as the ‘upper cultural layer’ and those from the 4th layer are referred to as being part of the ‘lower cultural layer’. In the upper cultural layer, there were 320 stone tools (point, side/end scraper, notched tool, drill, burin, utilized flake, biface, retouched flake, flake, pebble tool), 40 cores (Table 1), 2 pieces of ochre and 43 bones for a total of 405 artifacts. The findings in the lower cultural layer consisted of 75 stone tools (point, side/end scraper, drill, burin, utilized flake, retouched flake, flake, hammer stone, pebble tool), 30 cores (Table 2), and 1 rock crystal and 6 bones for a total of 112 artifacts. A total of 517 remains were thus excavated from the upper and lower cultural layers. Regarding, the southwest corner of the 2018 excavation, it should be noted that most of the upper cultural layer and some of the lower cultural layer had already been excavated as part of a test excavation conducted in 2017 which produced an additional 85 stone tools and 5 bones. Black shale and black flint comprises over 90% of the raw materials represented in both of the cultural layers. Outcrops of black shale can be seen around 200m away from these excavations, and black flint is a very common raw material at a number of Palaeolithic sites around the Karatau mountains. Both of these raw materials can thus be considered ‘local’.

4.3. The upper cultural layer

This cultural layer is comprised of dark brown coarse sand. Artifacts were densely distributed in the flat areas near the stream in both of the excavated areas (Figs. 5 and 6). Assuming that the low elevation area had also been the lowest point in the area surrounding the stream in the past, these artifacts were likely washed away when the stream deposited the 3rd layer of coarse sand.

In both the 2018 and the 2019 excavation areas, larger numbers of artifacts were found in the upper cultural layer than in the lower cultural

Table 2
The composition of the lithic industry of the lower cultural layer (number from wet-sieving).

	point	end-scraper	side-scraper	drill	retouched flake	utilized flake	flake	hummer	pebble tool	carinated core for bladelets	core	other	Grand total
Excavation in 2018													
black shale	1	2	2	2 (1)			18 (8)			2	8		35 (9)
black flint		7	13 (7)		1	1	4 (1)	1			5		32 (8)
agate			1		1								2
hornfels									1				1
crystal quartz												1	1
total	**1**	**9**	**16(7)**	**2(1)**	**2**	**1**	**22(9)**	**1**	**1**	**2**	**13**	**1**	**71(17)**
Excavation in 2019													
black shale		1	1		1		2			1	8		14
black flint		2	4 (1)		3 (2)		4 (2)	1		1	4		19 (5)
chert			1								1		2
total		**3**	**6(1)**		**4(2)**		**6(2)**	**1**		**2**	**13**		**35(5)**
Grand total	**1**	**12**	**22(8)**	**2(1)**	**6(2)**	**1**	**28 (11)**	**2**	**1**	**4**	**26**	**1**	**106(22)**

Fig. 6. The distribution of artifacts within the upper cultural layer of the Buiryokbastau-Bulak-1 site (excavation in 2018).

layer. The representative artifacts found in the upper cultural layer are shown in Fig. 7. The cylindrical microblade cores and the small side and end flake scrapers are distinctive. The tool ratio which is the value obtained by dividing the total number of points, end/side-scrapers, notched tools, drills, burins, pieces esquillées, utilized flakes, bifaces and retouched flakes by grand total number of artifacts (Table 1) was 59%, which is extremely high. Among the findings, there were 91 side scrapers and 61 end scrapers (Table 1).

4.4. The lower cultural layer

This cultural layer is comprised of dark brown silt soil and weathered bedrock soil. There is a clear differentiation from the upper cultural layer in the vertical distribution of the artifacts (Figs. 4 and 5). Artifact distribution appears to be centered around the left side of the stream bank (Figs. 5 and 8). As a result of the gentle current in the surrounding area of the spring, the stone tools were probably moved away from their original positions and deposited in the dark brown silt soil, accumulated as the 4th layer, and directly above the bedrock, mainly on the left side of the bank. Following the formation of the 4th layer (lower cultural layer), the coarse sand of the 3rd layer, which contains the upper cultural layer, was most likely deposited by a strong current that wore away portions of the 4th layer.

The stone tools found from the lower cultural layer are shown in Figs. 9 and 10. Bladelet cores were found in both excavation areas, with medium-sized blades of approximately 7 cm, blade cores, and end scrapers being distinctive findings. The tool ratio which is the value obtained by dividing the total number of points, end/side-scrapers, drills, retouched flakes and utilized flakes by grand total number of artifacts (Table 2) was 49%, which is again extremely high. In terms of the characteristics of the side scrapers and end scrapers, a distinctive difference between the two layers was observed, with larger blades used more frequently in the lower cultural (10 pieces) layer than in the upper cultural layer (0 pieces).

4.5. Stone tool typological similarities

The artifacts in the upper cultural layer were characterized by cylindrical microblade cores and small side and end scrapers. In terms of the form of the microblade cores, the materials found at the Karaungur (Караунгур) cave (Taimagambetov, Nokhrina, 1998) in the hilly areas at the western foot of the Karatau mountains and at exposed sites at the Shahantai (Шахантай)-1 site (Bekseitov 2007) located at the eastern foot of the Karatau mountains are similar to those from the upper cultural layer of Buiryokbasutau-Bulak-1. Although there are no firm radiocarbon dates in these other sites in the Karatau mountains, the form of microblade cores of these sites is typologically attributed to the Mesolithic period. In the lower cultural layer, the remains were characterized by bladelet cores, and side and end scrapers made with medium-sized blades of approximately 7 cm.

These carinated bladelet cores found in the lower cultural layer indicated a clear distinction between the two layers (Fig. 11). In what follows, we are particularly focused on the lower cultural layer.

Given that both the upper and the lower cultural layers contained fluvial sediment, it is unlikely that the artifacts were found in their original positions. This is especially true for the lower cultural layer, which was flattened when the upper cultural layer was deposited, potentially causing many stone tools to flow out. This is probably the reason why no bladelets were found despite wet-sieving being used. The deposition of the lower cultural layer was not uniform and consisted of

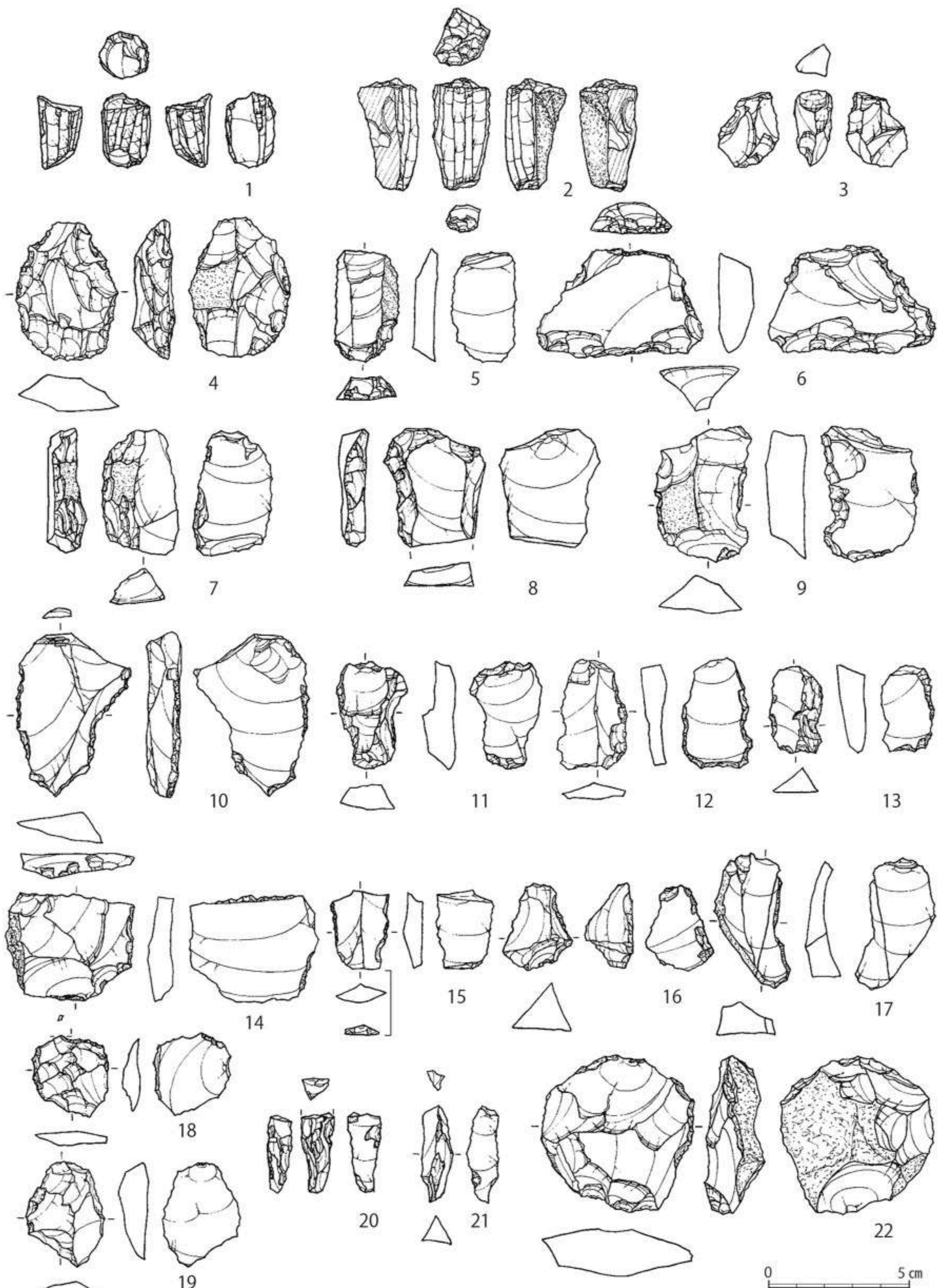

Fig. 7. Artifacts of the upper cultural layer of the Buiryokbastau-Bulak-1 site (1,2:microblade cores, 3, 22:cores, 4–6, 16:end scrapers, 7–14, 19, 20:side scrapers, 15: retouched flake, 17, 21:flakes, 18:drill) .

both clay and coarse sand. Therefore, in the period of the deposition of the lower cultural layer it seems that fluvial activity was stronger than it is today in the modern situation and the heavy disturbance by fluvial process effected the distribution of artifacts. Due to this, it seems that small artifacts did no remain in this area.

Fluvial processes clearly influenced the formation of the site. And artifact deposition should be considered as the result of redeposition. Nonetheless, vertical distributions of the two layers suggest a clear different. Although it seems to be an incomplete assemblage, when the composition of the carinated bladelet cores and the medium-sized blade

Fig. 8. The distribution of artifacts within the lower cultural layer of the Buiryokbastau-Bulak-1 site (excavation in 2018).

scrapers of the lower cultural layer are considered, and comparisons are made to other sites in Uzbekistan, Tajikistan, and the Altai region of Russia, the composition of the most compatible typological affiliation for the material appears to be the EUP.

In the EUP industries found in Uzbekistan and Tajikistan, bladelet production was more developed than in the surrounding areas and is thought to derive from the Kulbulakian tradition (Kolobova et al., 2014). On the other hand, in the southern parts of Kazakhstan, located to the north of those areas, there are no sites clearly identified as belonging to that tradition. In the northern foothills of the Tien Shan mountain range, EUP period bladelets have been excavated from the Kurama (КураМа) site in Kyrgyzstan (Fig. 1:4) (Charginov 2015) and from the Maibulak (Майбулак) site in Kazakhstan (Fig. 1:2) (Taimagambetov, Ozherelyev, 2009). However, since very few carinated bladelet cores have been found at these two sites, no clear conclusions could be drawn.

For this reason, carinated bladelet cores excavated from the lower culture layer at Buiryokbastau-Bulak-1 can be compared in more detail with those from Uzbekistan and Tajikistan, which are considered representative of the Kulbulakian tradition, in order to further inform existing hypotheses of technological spread and change in the region. The focus of these comparisons was on the size and morphology of the bladelets, as well as on the bladelet production technology used. The results of these comparisons were also used to validate the attribution of the lower cultural layer remains to the EUP period.

5. Analysis

5.1. Carinated bladelet cores negative scars analysis

Bladelet technologies from the lower cultural layer at Buiryokbastau-Bulak-1 were compared with those from other Kulbulakian tradition sites in western Central Asia to determine if there were commonalities in size and morphology. Since no bladelets were excavated from the lower cultural layer, the size and morphology of the "bladelet negative scars" left on the carinated bladelet cores form the basis of this comparison.

The size of the last negative scars on a core, of course, depends heavily on many circumstances, including the use and selection of raw material, the qualities of raw materials, the pattern of raw material acquisition/consumption and the characteristics of the settlement. Ideally, bladelets themselves should be compared. Nevertheless, negative scars can reflect the intended form and size of the final bladelet at least to some extent.

The carinated bladelet cores used for this comparison were taken from a total of 4 different sites and 5 different cultural layers: layer 1 at the Shugnou (Шугноу) site in Tajikistan, which is a known representative site for the Kulbulakian tradition (Fig. 1:9) (Kolobova et al., 2017); layers 2 and 3 at the same site; layer 2.1 at the Uzbekistan Kulbulak (Кульбулак) site (Fig. 1:7) (Kolobova et al., 2013); layer 4 at the Dodekatym (ДодекатыМ) −2 site (Fig. 1:6) (Kolobova et al., 2011), and; layer 2 at the Kazakhstan Maibulak (Майбулак) site.

A total of 65 bladelet negative scars of 13 carinated bladelet cores obtained from these other sites in Central Asia were analyzed. Similarly, 47 bladelet negative scars of 8 carinated bladelet cores (Fig. 9:27–28, Fig. 11) obtained from the lower cultural layer at the Buiryokbastau-Bulak-1 site were analyzed. As a control group, 15 microblade negative scars of 2 microblade cores from the upper cultural layer at the Buiryokbastau-Bulak-1 site (Fig. 6:1 to 6:2) were also analyzed.

First, the length and width of the negative scars were considered using a distribution diagram (Fig. 12) as a means of comparison, reflecting the size and morphology of the bladelets. Although the microblade core negative scars from the upper cultural layer tended toward the left side of the graph, the carinated bladelet core negative scars from the lower cultural layer and the other Central Asia sites were mixed together in the center, tending toward the right side of the graph and could not be differentiated from each other. The slope of the regression line was 4.27 for the upper cultural layer microblade cores, 1.47 for the lower cultural layer carinated bladelet cores, and 2.46 for the Central Asia carinated bladelet cores. This finding indicates a major difference between the former group and the latter two groups. The microblade negative scars of the microblade cores from the upper cultural layer had a long and narrow morphology, while the bladelet negative scars of the carinated bladelet cores from the lower cultural layer and the other Central Asia sites were wider and shorter.

Next, the length-width ratio (length/width) was calculated for each negative scar and, when the appearance frequency for each of the 3 groups was confirmed, it was shown to have a normal distribution. For this reason, one-way analysis of variance analysis was implemented in order to compare the length-width ratios between the 3 groups. This analysis detected a significant statistical difference in average values between the 3 groups (Fig. 13) ($P < 0.0001$, $F = 3.07$, upper cultural

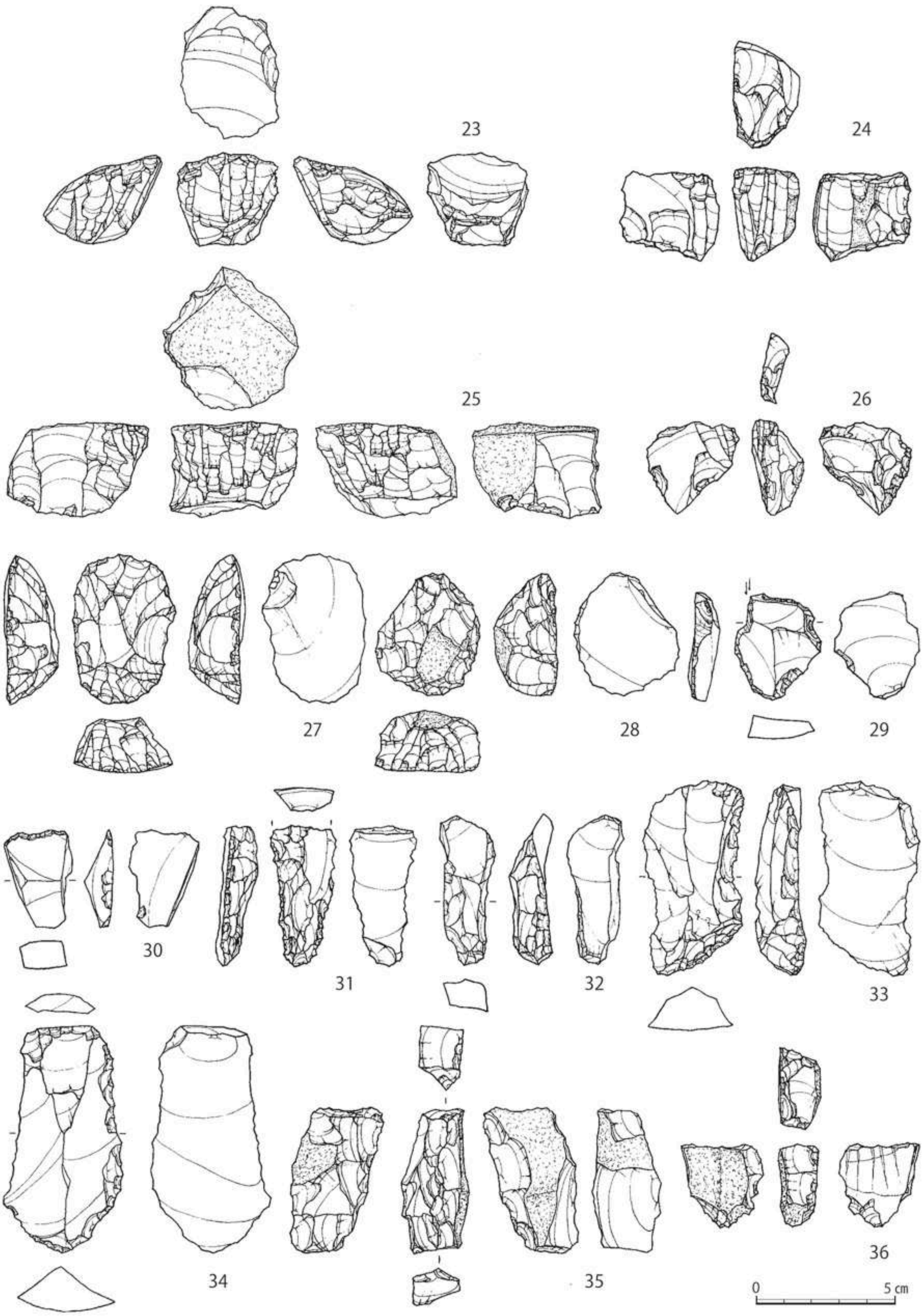

Fig. 9. Artifacts of the lower cultural layer of the Buiryokbastau-Bulak-1 site【1】(23–26: carinated cores for bladelets, 27, 28, 33: end scrapers, 29: burin, 30: utilized flake, 31–32, 34: side scrapers, 35–36:cores) .

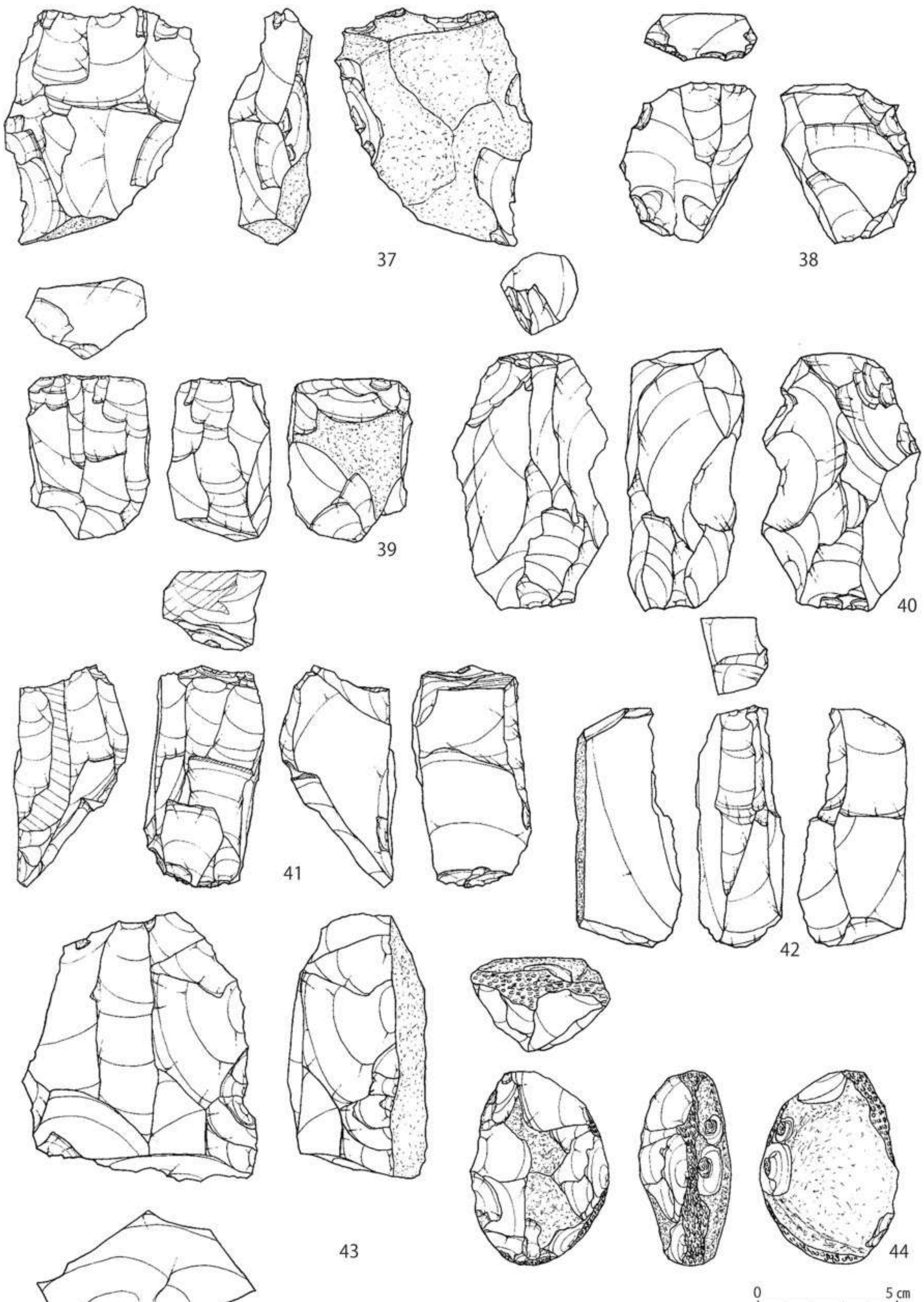

Fig. 10. Artifacts of the lower cultural layer of the Buiryokbastau-Bulak-1 site【2】 (37–43: cores, 44: hammer stone) .

layer: 7.55 average, 3.24 standard deviation; lower cultural layer: 4.35 average, 1.54 standard deviation; Central Asia sites: 4.01 average, 1.39 standard deviation).

Multiple comparisons were conducted to determine which groups had statistically significant differences between them. The results of these comparisons identified significant differences between the "upper cultural layer microblade cores" and the "lower cultural layer carinated bladelet cores," as well as between the "upper cultural layer microblade

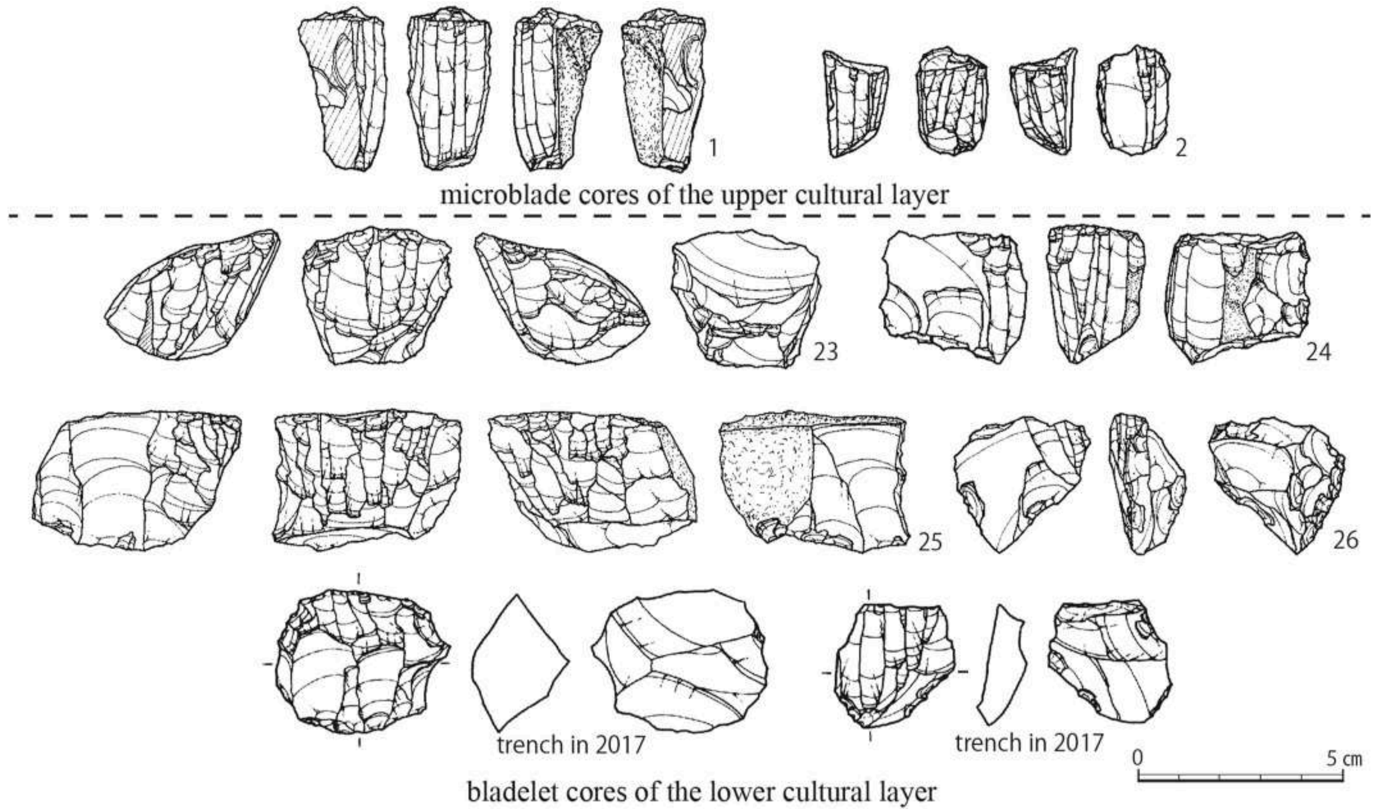

Fig. 11. Microblade cores of the upper cultural layer and carinated cores for bladelets of the lower cultural layer of the Buiryokbastau-Bulak-1 site.

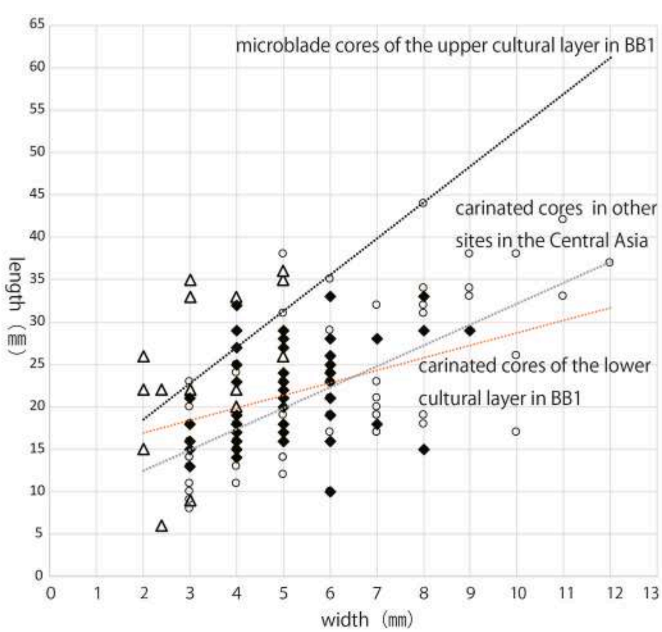

Fig. 12. The distribution of length/width ratio of bladelets or microblade fracture surfaces left on the surface of cores (△: fracture surfaces of microblades left on the surface of micrblade cores from the upper cultural layer of the BB-1 site,: fracture surfaces of bladelets left on the surface of carinated bladelet cores from the lower cultural layer of the BB-1 site, ○: fracture surfaces of bladelets left on the surface of carinated bladelet cores from other sites in the western Central Asia, the straight line shows regression line of each category) .

cores" and the "Central Asia site carinated bladelet cores" (Fig. 13) (upper cultural layer vs. lower cultural layer: $P < 0.0001$, $F = 4.001$; upper cultural layer vs. Central Asia sites: $P < 0.0001$, $F = 3.963$). In contrast, no statistically significant difference was identified between the "lower cultural layer carinated bladelet cores" and the "Central Asia site carinated bladelet cores" (Fig. 13) ($P = 0.23$, $F = 3.927$ following Bonferroni correction).

Based on these findings, if it is assumed that length-width ratios contribute to differences in morphology, the morphology of the detached bladelet pieces of the lower cultural layer carinated bladelet cores can, therefore, be seen to differ in a statistically significant way from the upper cultural layer microblades, but not the Central Asia site bladelet pieces. In other words, the carinated bladelet cores found in the lower cultural layer of Buiryokbastau-Bulak-1 show similarities in morphology to the carinated bladelet cores attributed to the EUP period found at other western Central Asia sites.

5.2. Carinated bladelet core production technology analysis

The following section compares the production technology characteristics of the carinated bladelet cores found in the lower cultural layer with the aforementioned materials from the other western Central Asian sites. The carinated bladelet cores excavated from the lower cultural layer of Buiryokbastau-Bulak −1 exhibit a variety of technological features involved in their production. Kolobova categorizes the carinated bladelet cores found in Uzbekistan and Tajikistan that derive from the EUP into 2 major categories involving 3 types ("a-type" and "b- and c-types") based on the usage of raw materials (Kolobova et al., 2014). For the first major "a-type" category of carinated bladelet core, the ventral side of the flake materials was set as the striking platform for bladelet production. This designation applies to artifact 23 from Buiryokbastau-Bulak-1, with an adjustable fracture applied within a wide-area coverage from the core surface to the striking platform (Fig. 14). Adjustment from the core surface side can also be seen on

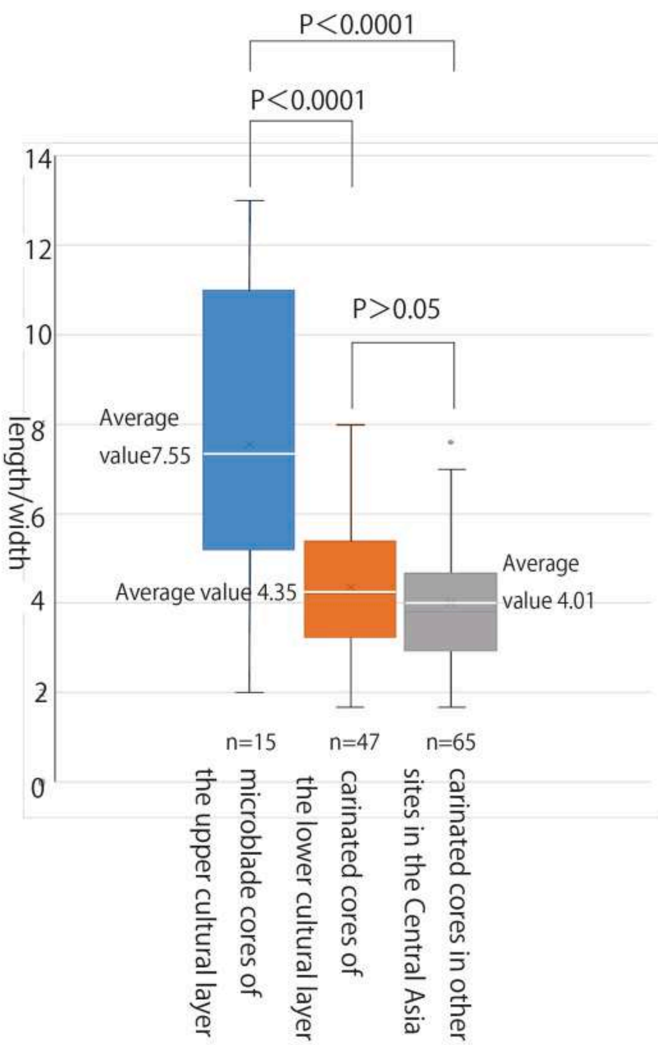

Fig. 13. The distribution of length/width ratio of fracture surfaces of each category (microblade cores from the upper cultural layer of the BB-1 site; carinated cores from the lower cultural layer of the BB-1 site; carinated cores in other sites in the Central Asia, boxes indicate 95% confidence intervals for the mean) .

Fig. 14: c. This type tends to have a gradual arc at the edges of the core surface when seen from the striking platform, and this was true for artifact 23 as well.

The second category comprised carinated bladelet cores with the ventral side of the material flakes set on the lateral side (Fig. 15). This category is divided into two types. Those with the striking axis set horizontally are designated "b-type" (Fig.15; 24, f) and those with the striking axis of the material flakes set vertically are designated "c-type" (Fig.15; 26, d, e). At Buiryokbastau-Bulak-1, artifact 24 is b-type and artifact 26 is c-type. In some cases, the striking axis of the material flakes is set diagonally, in between vertical and horizontal axes, which makes it difficult to make a clear distinction. For b- and c-type pieces, since the bladelet working surface is often set on the smaller side, narrow-width bladelets, as shown in Fig. 15: e, are easy to produce, and this appears to be the case for artifact 24 and artifact 26 as well. In addition, the striking platform tends to have the same long and narrow morphology as the core surface. As shown in artifact 26 and in Fig. 15: f, the striking platform is often adjusted from the side.

Kolobova's classification system, involving two categories (divided into "a-type" and "b- and c-types"), appears useful in classifying the carinated bladelet cores from Buiryokbastau-Bulak-1. However, when considered from the viewpoint of material usage, certain samples, such as those seen in Fig. 16: g that show the use of subangular pebbles, could be considered as a further distinctive category (Fig. 16). These samples are designated here as a "subangular pebble type." From Buiryokbastau-Bulak-1, artifact 25 is one example of this type.

If material usage is used as a classification standard, it should be theoretically possible to classify all the samples into one of three major categories including the new category comprising the subangular pebble type. However, if consistency of material usage is overly emphasized, distinctive forms may not be detected. In addition to the most common "wedge-shaped type", the following 3 distinctive morphologies in relation to carinated bladelet cores deserve special mention.

The first type is shown in Fig. 17: i, j, and k. This type has a flat, pyramidal morphology with the bladelet fracture spreading out in a plane. This can be called a "flat prism type." One example from the test excavation carried out at the target site in 2017 is shown (Fig. 17). In terms of material usage, these are often both b-type and c-type.

The next type features, a surface with opposing striking platforms and with bladelet negative scars oriented opposite one another (Fig. 18). This causes the vertical cross-section to form a diamond or lens shape. It could also be described as having a roof-shaped striking platform shape with an opposite fracture convex working surface. For the purposes of this paper, the new term "Buiryokbastau-Bulak type" is used for this type, which corresponds to a sample excavated from the target site in 2017.

Other examples of this type of carinated bladelet core include Fig. 18: l and m obtained from the other western Central Asian sites and materials excavated from the Sorukori site during the 2018 general survey carried out in the Karatau mountains of southern Kazakhstan (Kunitake 2019b). Similar samples have also been found at other sites involving EUP industries in the Russian Altai region, Siberia, and northern China. While the "a-type" classification is generally applicable, if the flake material forms a large flat surface on the side and the flakes themselves are thick, the piece is considered representative of the "Buiryokbastau-Bulak type."

Finally, there are also carinated bladelet cores with bladelet fracture working surface lengths shorter than their width, very similar to end scrapers (Fig. 19). This was the case with artifacts 27 and 28 from the target excavation site, which are identified as end scrapers in this paper. On the other hand, Fig. 19: n, o, and p are identified as carinated bladelet cores. For the purposes of this paper, this type of core is referred to as an "end scraper-like type." Within the "a-type" classification, these cores have a working surface length around half of the width and their angle of striking platform is close to perpendicular.

6. Discussion

We used the two major categories of the Kolobova material flake usage classification system ("a-type" and "b/c-types"), with one additional type ("subangular pebble type") along with 3 newly defined distinctive shape classification types ("flat prism type", "Buiryokbastau-Bulak type" and "end scraper-like type") to classify the lithic artifacts studied herein. These general classifications and subdivisions are set out in Table 3. For the 6 carinated bladelet cores and 2 possible carinated bladelet cores excavated at the target site, the breakdown was as

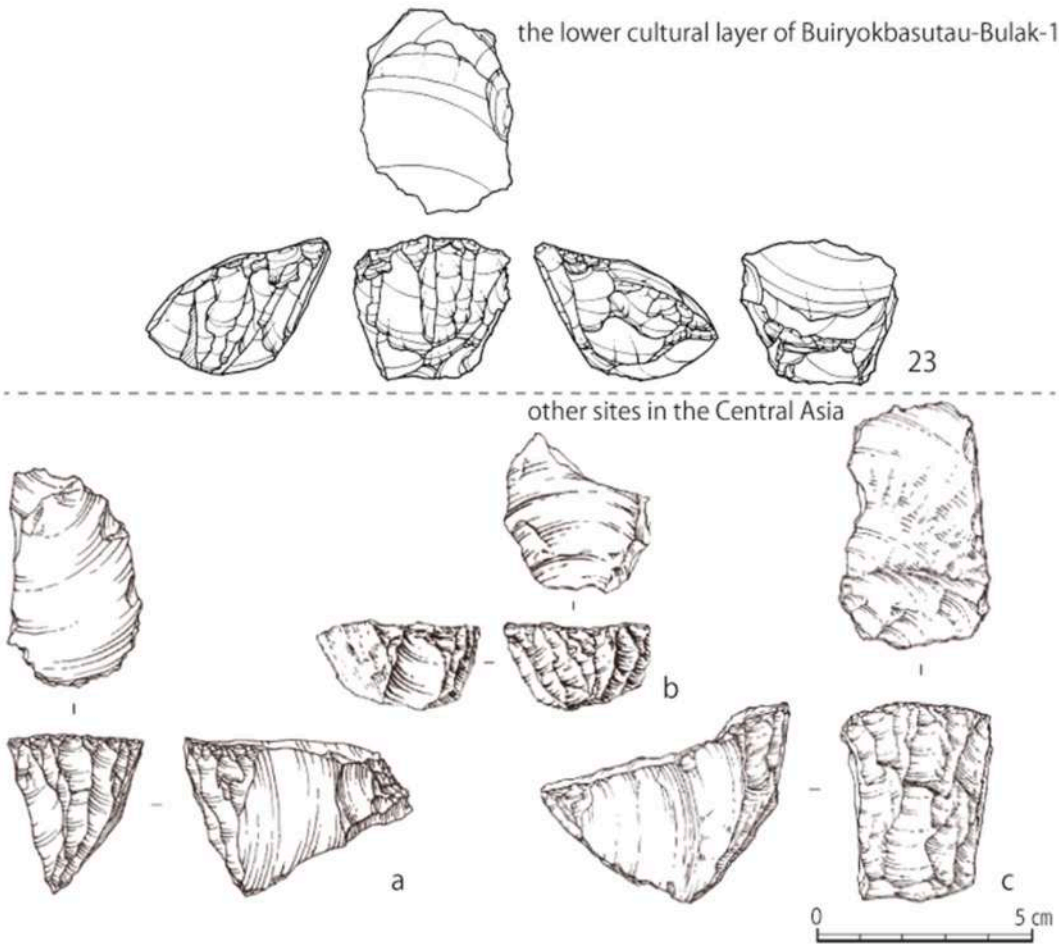

Fig. 14. Transversally carinated bladelet cores (a-type) (Kolobova et al., 2014) (a: Shugnou layer 1, b: Dodekatum-2 layer 4, c: Dodekatum-2 layer 2, 23: the lower cultural layer of the Buiryokbastau-Bulak-1 site) .

follows: 1 “a-type” (artifact 23), 2 “b- and c-types” (artifacts 24 and 26), 1 “subangular pebble type” (artifact 25), 1 “flat prism type” (2017 test excavation), 1 “Buiryokbastau-Bulak type” (2017 test excavation), and 2 “end scraper-like types” (artifacts 27 and 28). In addition to being found at Buiryokbastau-Bulak-1, representative bladelet cores of all 6 of these types have also been found at sites of Kulbulakian tradition industries in Uzbekistan and Tajikistan (Table 3). This means that the lower cultural layer at Buiryokbastau-Bulak-1 contains carinated bladelet cores that have technological and morphological features in common with the Kulbulakian tradition, further suggesting that the lower cultural layer can be attributed to the EUP.

It is useful to consider which of the Kulbulakian tradition industries in the other Central Asian sites are most similar to the lower cultural layer at the Buiryokbastau-Bulak-1 site in terms of carinated bladelet core technology and morphology. According to Table 3, all 6 types are shown to have been present in both the lower cultural layer of the target excavation site and in a comparative group in layer 1 at the Shugnou site in Tajikistan. Also, the remains of 4 of the types are present in layer 2.1 at the Kulbulak site. Both these sites appear closest to the lower cultural layer the Buiryokbastau-Bulak-1 site in terms of technological and morphological characteristics within the considered region. Both sites are assumed to originate from the middle period of the Kulbulakian tradition (about 31-33ka cal BP), which is considered as the time during which bladelet production was at its most advanced (Kolobova et al. ibid.). Although two other types were found to be present, the bladelet cores of the extremely distinctive “Buiryokbastau-Bulak type” morphology found in layers 2 and 3 at the Shugnou site are especially significant (Fig. 18). The carinated bladelet cores found in layers 1, 2 and 3 at the Shugnou site have a strong technological and morphological similarity with the carinated bladelet cores found in the lower cultural layer at Buiryokbastau-Bulak-1. Medium-sized blade cores with double opposite striking platforms excavated from the lower cultural layer at Buiryokbastau-Bulak-1 were also found in both the Shugnou and Kulbulak sites (Fig. 20), which provides further evidence of similarity between these sites.

These findings show that bladelet production and blade production coexisted within Kulbulakian tradition industries of the EUP period in Central Asia. Although both these technologies were contemporaneous and necessary for prehistoric people, each technology was utilized at certain places and times, which means that the ratio of the number of carinated bladelet cores and medium-size blade cores is likely to vary depending on the site. Differences in that ratio could, for example, reflect the differences in subsistence activities among the sites (Kunitake 2019c).

In dating the lower cultural layer at the target excavation site, the findings from other sites need to be considered. At the Shugnou site

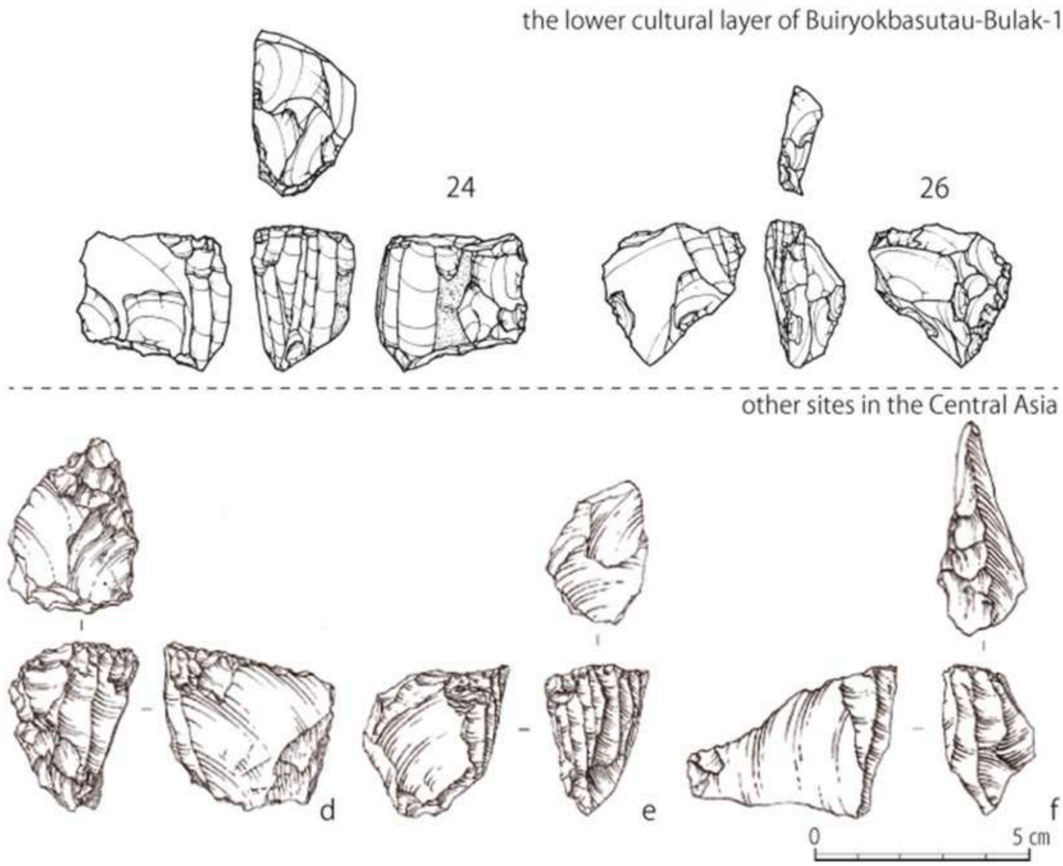

Fig. 15. Longitudinally carinated bladelet cores (b/c-type) (Kolobova et al., 2014) (d,f: Kulbulak layer 2.1,e: Shugnou layer 1, 24·26; the lower cultural layer of the Buiryokbastau-Bulak-1 site) .

where artifacts in common with those in the lower cultural layer at Buiryokbastau-Bulak-1 have been found, the dating of the 1st layer has recently been published. Radiocarbon dating determined that associated animal bone and charcoal could be dated to 31,301–31,134 cal BP and 32,930–32,561 cal BP, respectively (Kolobova et al., 2017). Optically Stimulated Luminescence dating of the 2nd cultural layer at the Kazakhstan Maibulak site has recently shown it to be dated to 31.0 ± 3.0 ka BP and 33.0 ± 2.9 ka BP (Fitzsimmons et al., 2017). The total combined age range, from 33,000 to 31,000 years ago, indicates that the industries found in these sites are from the latter EUP period. Since the lower cultural layer at the Buiryokbastau-Bulak-1 site is close to the surface and deposited at a shallow depth, the effects of cosmic rays cannot be ignored, and the extent of modern-day carbide contamination is expected to be high. As a result, accurate dating was considered difficult and no scientific dating analysis has yet been implemented, although further attempts are needed for high-resolution dating analysis. Based on dating at the Shugnou site, whose artifacts share technological and morphological characteristics with artifacts from the Buiryokbastau-Bulak-1 site, the lower cultural layer is estimated to range in age from 33,000 to 31,000 years and can be attributed to the latter half of the EUP period.

7. Conclusions

In excavations undertaken at the Buiryokbastau-Bulak-1 site, two cultural layers were found containing microblade cores and carinated bladelet cores, with no significant disturbance of stratigraphic distribution detected. Each cultural layer was considered as an internally consistent collection of materials, despite observed fluvial activity involved in their deposition. In western Central Asia during the EUP period, the distinctive features of bladelet production within the Kulbulakian tradition have been well-documented. However, although there are good examples of carinated bladelet cores in Uzbekistan and Tajikistan, it has been unclear until now whether the Kulbulakian tradition extended to Kazakhstan as well. Although no bladelets were found in the lower cultural layer at the target excavation site, a total of at least 8 of the typical types of carinated bladelet cores that normally accompany medium-sized blade tools were excavated. These were compared in detail with those carinated bladelet cores recognized as belonging to the Kulbulakian tradition that have been found in Uzbekistan and Tajikistan. These comparisons showed that there were no statistically significant differences between bladelet negative scars left on the carinated bladelet cores found in the lower cultural layer at the excavation site and those found at the other sites in Central Asia, indicating morphological similarity. In addition, when the carinated bladelet cores were classified into 3 main categories and divided further into 6 types (Table 3), and site comparisons undertaken, all 6 types were identified at the Buiryokbastau-Bulak-1 site and at the other sites in Central Asia, confirming considerable commonality in the technological and morphological characteristics of the carinated bladelet cores. Because the Shugnou site showed considerably greater commonality to Buiryokbastau-Bulak-1, the dating of this site was used as a reference for

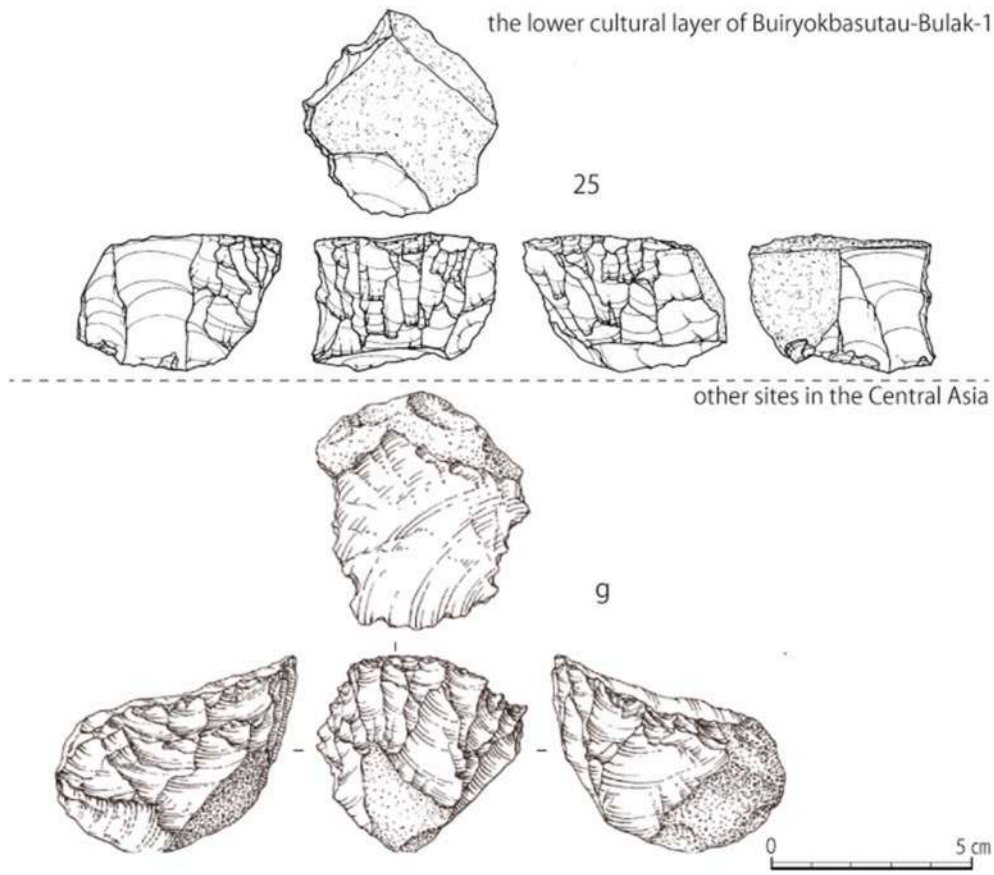

Fig. 16. ‘Subangular pebble type’ of carinated bladelet cores (g: Shugnou layer 1, 25: the lower cultural layer of the Buiryokbastau-Bulak-1 site) .

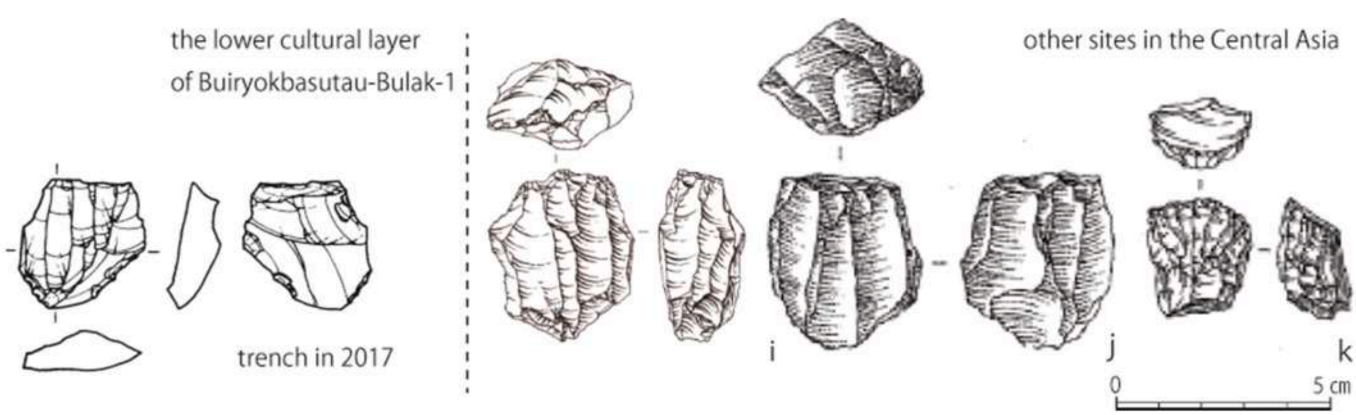

Fig. 17. ‘Flat prism type’ of carinated bladelet cores (i: Kulbulak layer 2.1,j: Maybulak layer 2, k: Shugnou layer 1, trench in 2017: the lower cultural layer of the Buiryokbastau-Bulak-1 site) .

the lower cultural layer. Using this approach, the findings of this excavation add to the currently limited evidence suggesting bladelet production was being carried out during the latter half of the EUP period in southern Kazakhstan.

Based on findings in relation to the lower cultural layer of Buiryokbastau-Bulak-1, we argue that bladelet production was being carried out in southern Kazakhstan during the latter half of the EUP using the same technology as employed within the Kulbulakian tradition. Future studies should investigate the development of EUP industries in western Central Asia in detail and seek to assess more precisely those aspects of industries conducted within the Kulbulakian tradition and with good dating. For the moment, the findings from the lower cultural layer at the target excavation site are of critical importance as they comprise materials that provide fundamental evidence of bladelet production in southern Kazakhstan. This new evidence will help us to understand how modern human adapted to different parts of Central Asia and how their technologies changed through time.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

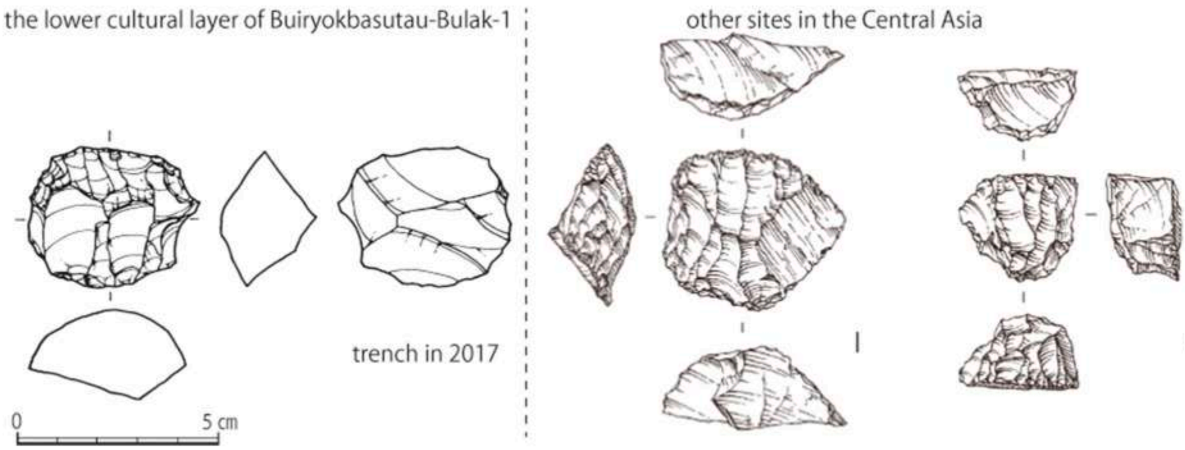

Fig. 18. 'Buiryokbastau Bulak type' of carinated bladelet cores (l: Shugnou layer 3-2,m: Shugnou layer 1, trench in 2017: the lower cultural layer of the Buiryokbastau-Bulak-1 site) .

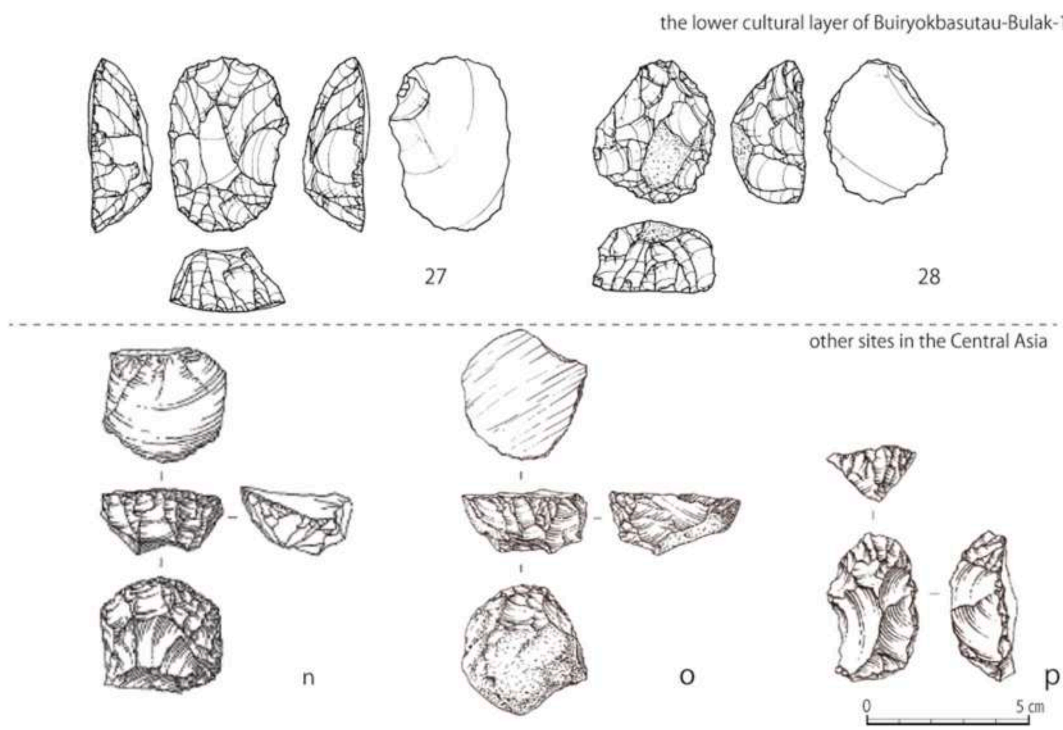

Fig. 19. 'End scraper-like type' of carinated bladelet cores (n,o: Shugnou layer 1, p: Kulbulak layer 2.1, 27·28: the lower cultural layer of the Buiryokbastau-Bulak-1 site) .

Table 3
Classification of carinated bladelet cores in western Central Asia.

Material form	Major classification according to be used material	Subdivision by form of core	Fig. no.	Buiryokbastau Bulak-1 the lower cultural layer	Shugnou layer 1	Shugnou layer 3-2	Kulbulak layer 2.1	Dodekatum-2 layer 4	Maybulak layer 2
flake	Transversally carinated cores (a type) (Kolobova et al., 2014)	wedge shaped	14	●	●	●	●	●	
		Buiryokbastau -Bulak type (this article)	18	●	●	●			
		End scraper-like type (this article)	19	●	●		●		
	Longitudinally carinated cores (b/c type) (Kolobova et al., 2014)	wedge shaped	15	●	●		●		●
		Flat prism type (this article)	17	●	●		●		●
Pebble	Pebble type (this article)	–	16	●	●				

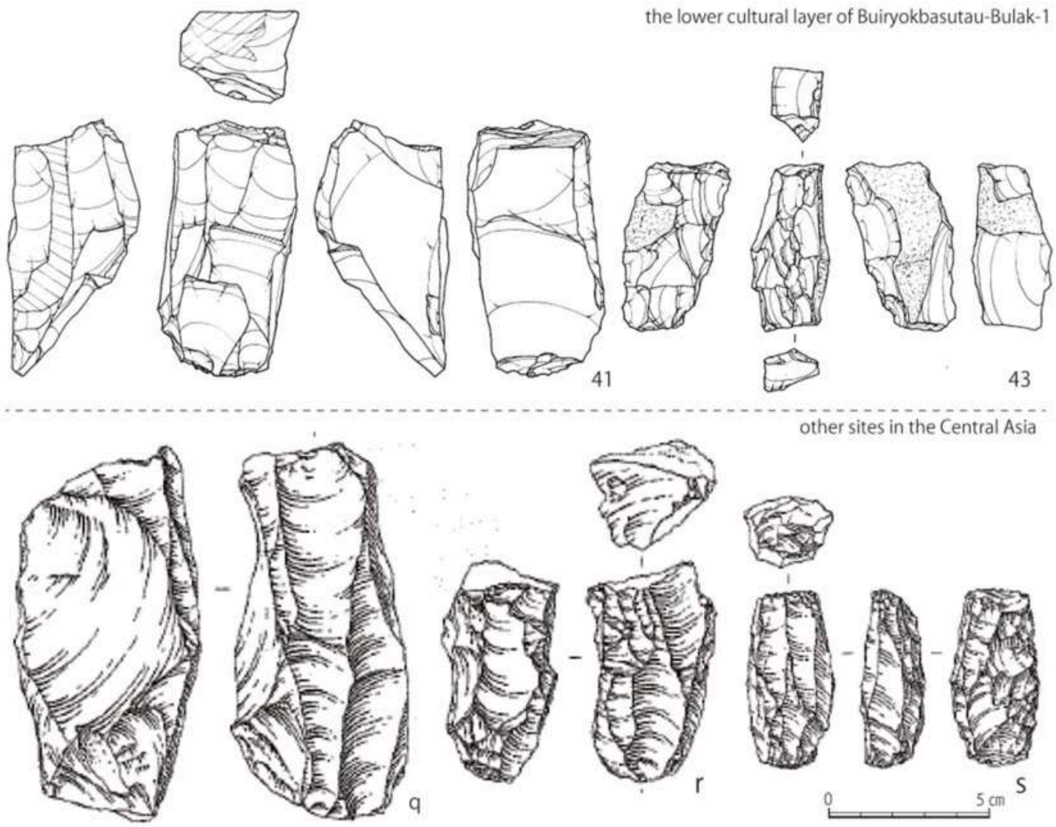

Fig. 20. Cores and preforms for medium-sized blades (q,r: Kulbulak layer 2.2, s: Shugnou layer 3-2, 41·43: the lower cultural layer of the Buiryokbastau-Bulak-1 site).

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