

垂杨介遗址第6地点第3文化层出土的旧石器晚期早段 石叶研究

李宪宗¹ 张亨吉² 李隆助³

1. 韩国国立木浦大学考古与文化人类学系, 木浦 58554;
2. 韩国忠清北道文化财研究院, 清州 28353; 3. 韩国先史文化研究院, 清州 28763

摘要 垂杨介是研究朝鲜半岛旧石器时代晚期石叶技术体系的重要遗址, 为探讨东北亚石叶技术体系的起源与演进提供了丰富的信息。在该遗址第6地点第3—4层的文化内涵被揭示之前, 朝鲜半岛被认为属于保守、落后的旧石器文化圈的一部分, 石叶技术产品在旧石器时代遗存中缺失。但新的发现与研究表明, 该地区是东亚具有独特旧石器时代晚期技术体系的区域, 石叶技术遗存与砾石文化传统在这里并行发展。该地点第3文化层出土的石制品反映了朝鲜半岛旧石器时代晚期早段文化的特点。根据对石制品组合的分析, 该层很可能代表一处获取石叶进而制作带铤尖状器的石器制作场, 与该地点第4层功能接近。该层石器技术体系的主要特点是中小型石叶增多, 原始细石叶技术初露端倪, 利用半楔形石核连续剥制石叶, 纵向剥片生产石叶, 并有效利用这些石叶制作带铤尖状器。第3—4层石叶技术体系(较之前)最大的变化体现在石叶尺寸及一系列相关的演进, 包括对原料的选择。这一发展过程应该与特定生计行为模式对中小型石器需求的增加密切相关。这种模式是旧石器时代晚期早段石叶技术演变的典型特点。而第3文化层也与旧石器时代晚期晚段遗址特点具有紧密联系。

关键词 垂杨介遗址第6地点; 旧石器时代晚期早段; 石叶; 石叶生产; 带铤尖状器; 细石叶; 细石叶生产

1 Introduction

The Suyanggae Locality VI site, located in Danyang-gun, North Chungcheong Province, Republic of Korea, was excavated between 2013 and 2015. This site is of paramount importance, serving as a key to unlock our understanding of Late Paleolithic blade technology on the Korean Peninsula. The site comprises four cultural layers, each serving as a workshop for the intensive production of stone tools. The artifacts discovered in these layers exhibit distinct characteristics, reflecting variations in tool-making practices over time^[1,2].

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作者简介: 李宪宗, 教授, 主要从事旧石器时代考古学研究。E-mail: ruslee@mokpo.ac.kr

*通信作者: 张亨吉, 研究员, 主要从事旧石器时代考古学研究。E-mail: janghg86@naver.com

The Paleolithic cultural layer at Suyanggae Loc. VI (SYG-6) reveals unique cultural attributes, offering an integrated view of the organization of technology used in the blade industry by modern humans. This spans from the Early Upper Paleolithic blade culture (approximately 40-45ka) to its microblade successors. The site provides diverse archaeological evidence essential for studying the Late Paleolithic blade culture on the Korean Peninsula.

The third cultural layer (CL 3) at SYG-6 is primarily distributed in the western part of the excavation unit, yielding 7,470 stone artifacts. Shale accounts for most of the raw materials (6,115 artifacts; 81.9%), with other raw materials being sparsely represented. While medium- and small-sized blades and tanged points dominate production, the proportion of formally shaped stone tools, excluding tanged points, is notably low, indicating a relatively simple stone tool composition. Nevertheless, the primary products, such as blades, exhibit characteristics typical of the Early Paleolithic in Northeast Asia.

Recent research on the Upper Paleolithic has emphasized the diffusion process of blade technology, focusing on analyzing blade-making techniques in this region. Moreover, it has been suggested that the regional characteristics of Northeast Asia, including Siberia, Mongolia, and North China, do not conform to preexisting European research perspectives^[3-5].

Northeast Asia has long been recognized as a region displaying a unique Upper Paleolithic stone tool-making tradition, where blade production coexisted with a pebble tool tradition. The excavation at SYG-6 has recently highlighted the primary characteristics of the Early Upper Paleolithic in the Republic of Korea^[6].

However, there remains a gap in research addressing the evolution of the blade technological organization during the Early Upper Paleolithic and the changes over time. Therefore, this study compares and analyzes the production by blade technology uncovered in CL 3 and CL 4.

This paper aims to comprehensively analyze blade technology, specifically in CL 3 of SYG-6. Then, it will explore technological changes over time by comparing blade technology between CL 3 and CL 4. Additionally, this study will examine and discuss the significance of blade technology during the Early Upper Paleolithic period in Korea.

2 Characteristics of the Tool Technology: Core and Blade

Among the nine stratigraphic layers, CL 3 was identified in the middle to lower parts of the yellowish-brown clay layer. This layer is generally distributed throughout the site, with the color tone gradually darkening from the top to the bottom. The thickness of the cultural layer ranges from 20 to 50 cm. In contrast, CL 4 is separated by a distinct boundary from the reddish-brown sandy clay layer (Fig. 1).

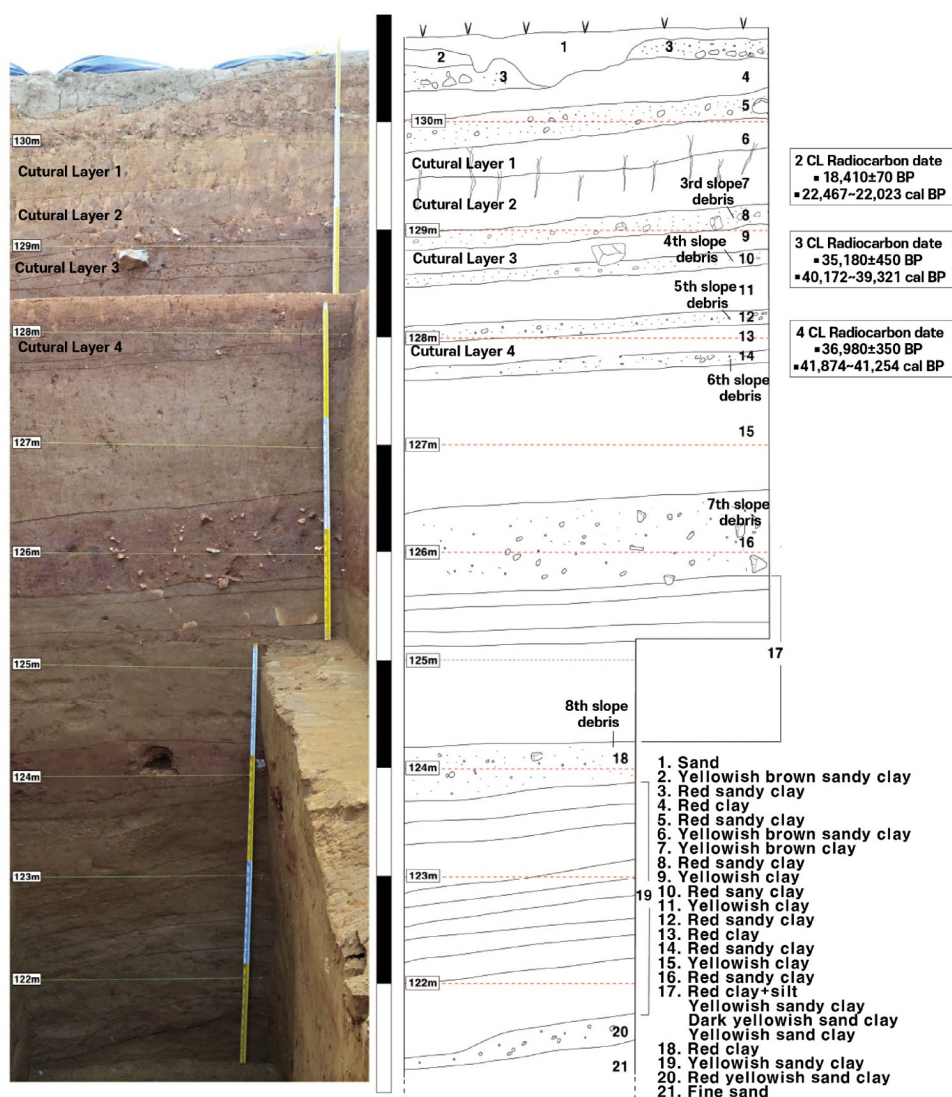


Fig.1 Stratigraphic map in SYG-6

图1 垂杨介遗址第6地点地层图

2.1 The core shaping process and the system of flaking

A total of 254 cores from CL 3 were excavated. The primary raw materials used for the cores were shale (50%) and quartz (19.6%), with smaller amounts of quartzite, hornfels, amphibolite, and sandstone also present. The homogeneous nature of the shale particles indicates that sophisticated work was possible during the core shaping and flake production processes. The number of flake removals on the working surfaces of the cores ranged from 1 to 40, with an average of 8.8 pieces removed per core. The angle at which flakes were removed averaged 87.8°, suggesting that vertical

flaking was predominant.

A total of 4,828 flakes were recovered, with the raw materials consisting of shale (4,191; 86.8%), quartz (531; 11%), hornfels (58; 1.2%), quartzite (19; 0.4%), siliceous schist (9; 0.17%), rhyolite (7; 0.11%), amphibole (4; 0.1%), siliceous gneiss (4; 0.1%), sandstone (4; 0.1%), and tuff (1; 0.02%). The proportion of shale used for flakes is consistent with that used for the cores. The average dimensions of the flakes were 37.4 mm×32.2 mm×10.9 mm.

2.1.1 Organization of the blade core technology

In CL 3, 631 débitage pieces related to blade production were excavated. Among these, there were 53 blade cores (8.4%) and 578 blades (91.6%), resulting in a blade core-to-blade ratio of 1:11. All blade cores were made from shale (100%), and they primarily exhibited a square form with similar length, width, and thickness. When examining the ratio of natural surfaces to facets on the blade cores, the majority (52 pieces) had less than 25% remaining natural surface, indicating that the shaping process, such as adjusting the striking platform and edge angle, was crucial for successful blade production.

Regarding the striking platforms of the blade cores, 44 were found on structured platforms and 10 on the cortex. Most striking platforms were prepared by striking the surface at least once, and in some cases, multiple times, to obtain a high-quality striking platform. Examining the location of the working face, a single working surface was most common, with 39 pieces, followed by 8 with two working surfaces, 5 with three working surfaces, and 1 with four working surfaces. Most cores were struck in the same direction on a single strike platform.

The blade cores were classified based on the correlation between the striking platform and the working surface. This study categorized them into five main types (A to E) based on striking platform and working surface characteristics. They were further classified into 13 subtypes (A1 to E5) according to the location of the working surface^[7] (Fig. 2).

Table 1 identifies nine types of blade cores excavated from CL 3. The most significant proportion is type A, which has one striking platform and one working surface.

More specifically, each core exhibited distinct characteristics. First, cores with one striking platform and one working surface represent a technical organization where blades were continuously produced in the same direction from a single working surface after forming one striking platform. This is a typical blade technology commonly found in workshops where fine-grained raw materials were readily available at the site (Fig. 3).

Second, cores with one striking platform and two working surfaces were produced so the working surfaces were adjacent. Blades were initially produced on the narrow side, followed by blade production on the adjacent, wider working surface (Fig. 4:1).

Third, cores with two striking platforms and one working surface had the striking platforms

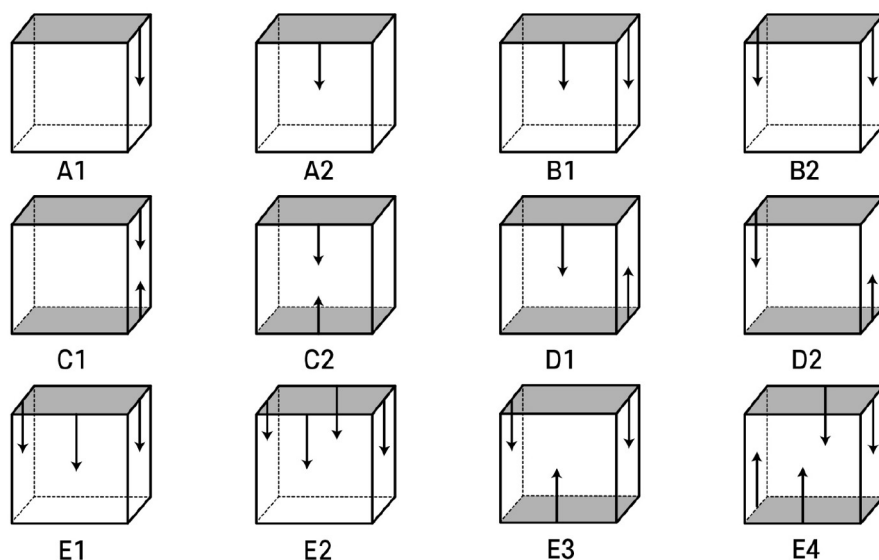


Fig.2 Classification of the blade core

图2 石核的分类

Tab. 1 The classification of the blade core in CL 3

表1 第3文化层出土石核的分类

Type	A1	A2	B1	C1	C2	D1	D2	E2	E4
Number	17	15	3	2	5	1	4	5	1

facing each other. Blades were produced from one striking platform on the working surface, and then the other striking platform was used to produce blades from the same working surface (Fig. 4:2-3).

Fourth, smaller quantities of cores with two striking platforms and two working surfaces were excavated from CL 3. These cores had striking platforms facing each other and parallel working surfaces.

Fifth, two striking platforms facing each other were created for cores with multiple working surfaces, and blades were produced on three to four working surfaces while rotating the core. These cores appear to demonstrate the technology used in Northeast Asia to efficiently exploit raw materials for blade production (Fig. 4:5-6).

In CL 3, the most common blade core had one striking platform and one working surface, likely due to the availability of fine-grained raw materials in the surrounding area. Additionally, sub-wedge-shaped cores were identified among the cores with one striking platform and one working surface, where blades were produced after forming the striking platform on the narrow side. This core exhibited the same technical organization as the original microblade type, making

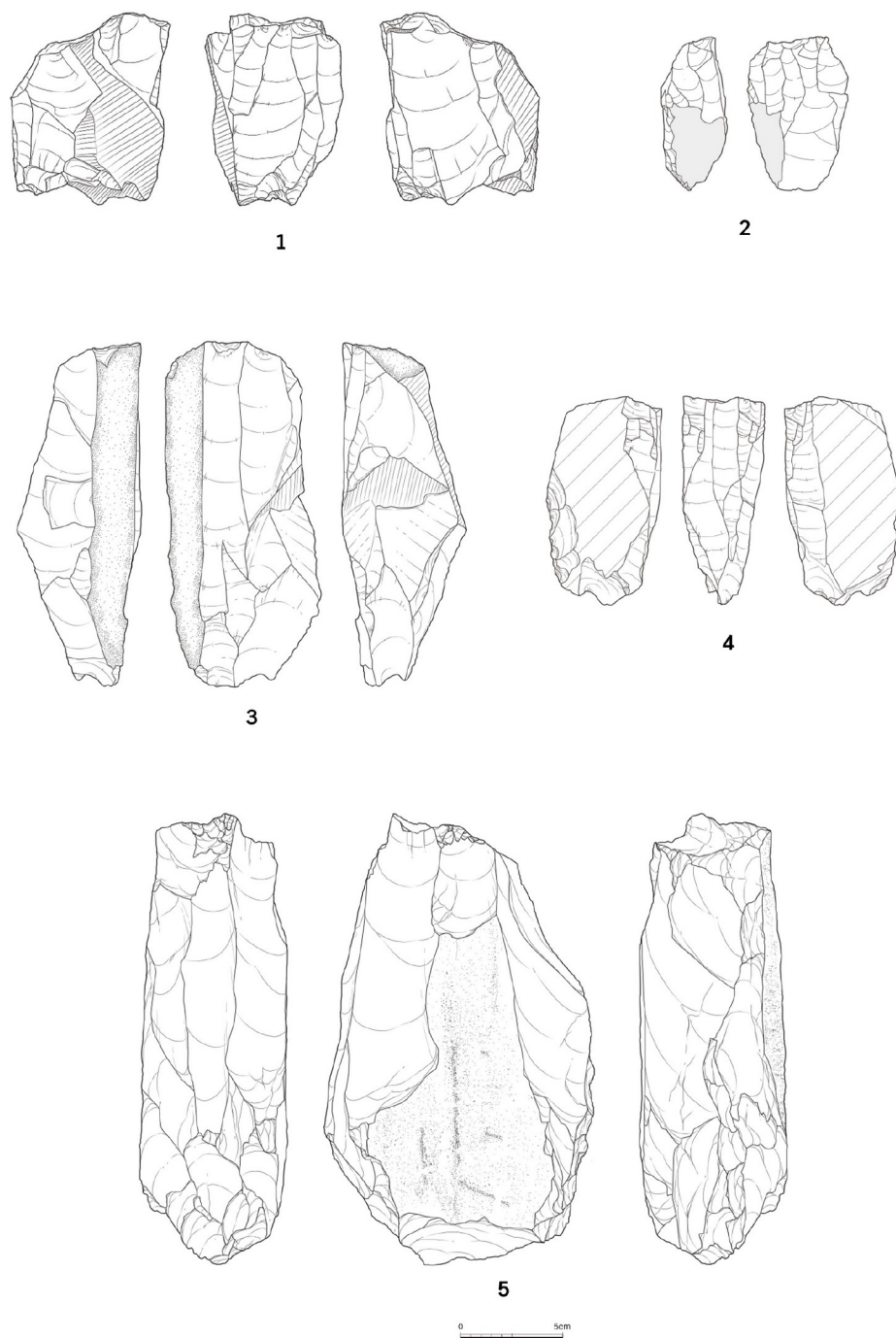


Fig.3 Type A in CL 3

图3 第3文化层出土的A型石器

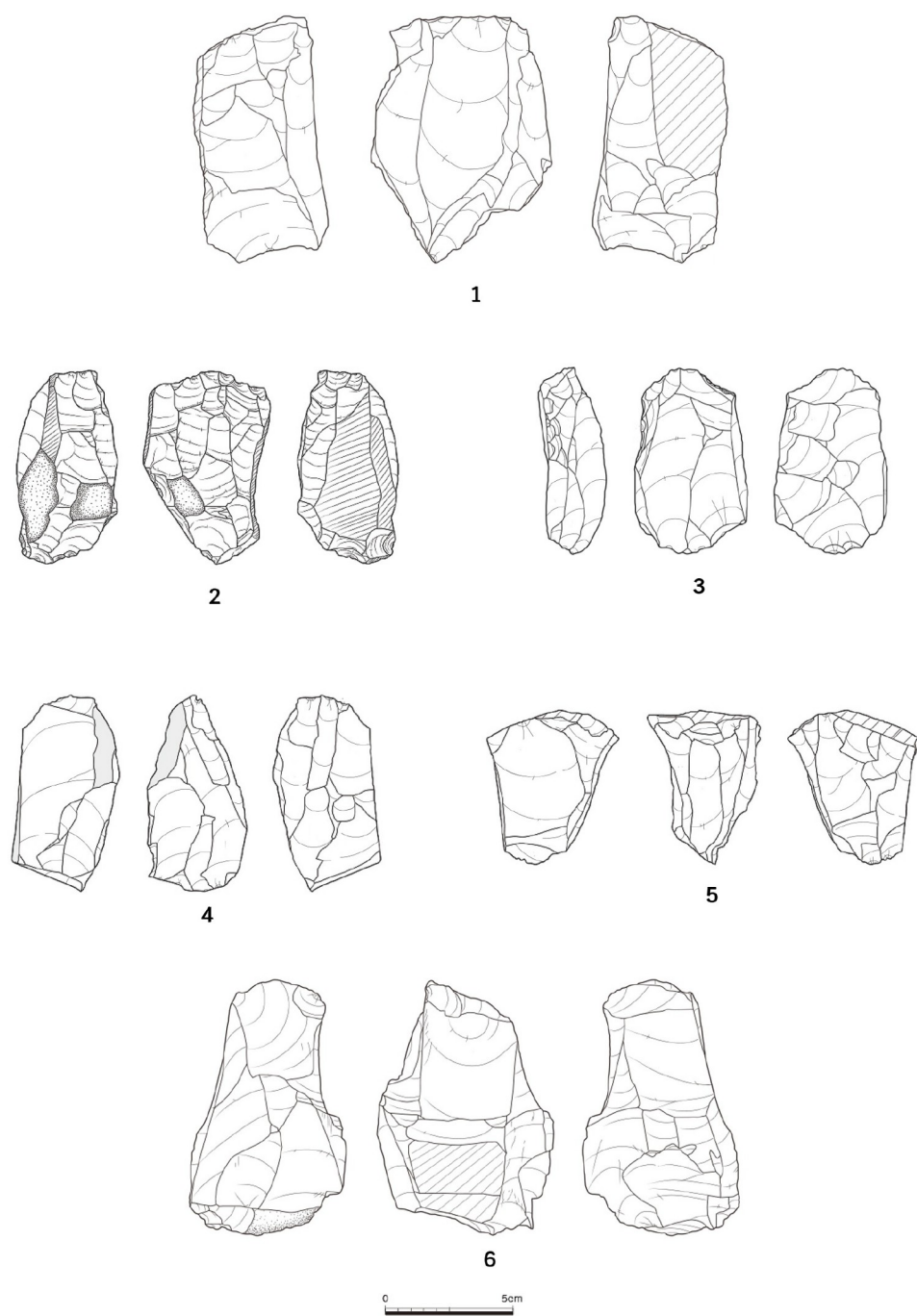


Fig.4 Types B(1), C(2-3), D(4), E(5-6) in CL 3

图4 第3文化层出土的B(1)、C(2—3)、D(4)、E(5—6)型石器

it economically feasible to produce many blades^[8]. Large blade cores, with lengths exceeding 10 cm, were also identified, indicating that the large blade technological production from the previous period persisted into CL 3.

2.1.2 Small blade core and microblade core

In CL 3, two microblade cores, three microblade core preforms, one microblade technical flake, and 16 microblades related to the microblade culture were excavated. The sizes range from 12 to 24.6 mm in length, 5.2 to 8.4 mm in width, 1.7 to 5.2 mm in thickness, and 0.1 to 0.5 g in weight (Fig. 5).

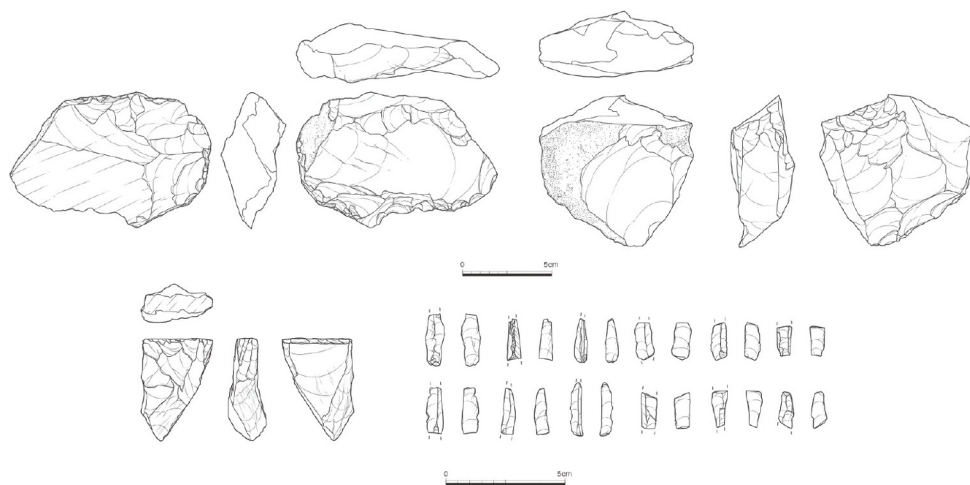


Fig.5 Microblade and microblade core in CL 3

图5 第3文化层出土的细石叶与细石核

The microblade core was formed either on a flat cortex or after removing a spall to create a striking platform. Microblades were produced from the narrow side without special treatment to the core body. These were produced by vertical flaking, a method more akin to the technology used for small blade cores than the typical microblade technological organization^[9].

The shape of the microblade core is not wedge-shaped but rather primitive, displaying simple technical characteristics that utilize the original shape of the core without modifications. This primitive type of microblade core closely resembles the ‘small blade core’ technology. The presence of microblades within the blade technological organization is a widespread phenomenon. It is one of the technological types found in the Karakol type in the Altai region of North Asia^[10,11].

However, determining whether the primitive microblade cores excavated from the site should be classified as small or microblade cores requires consideration within the broader context of the blade core assemblage. The condition of the striking platform is consistent with that of microblade

cores, with three exhibiting a removed striking platform on one side and one retaining the cortex.

Additionally, seven small blade cores were excavated, with shale being the primary raw material. The small blade core technological production involved producing blades from the narrow side through vertical flaking after adjusting the striking platform. Although the blades produced were not microblades, the technological organization used for blade production was nearly identical to that of microblade manufacturing, suggesting a correlation with the microblade technology.

2.1.3 The characteristics of the blades

578 blades were excavated from CL 3, consistent with the distribution range of blade cores and hammers. Shale accounted for the majority, with 569 blades (98.2%), followed by hornfels (4 blades; 0.7%), tuff (4 blades; 0.7%), quartz (1 blade; 0.2%), and rhyolite (1 blade; 0.2%).

The blades ranged in size from 13 to 164 mm in length, 6 to 75 mm in width, and 3 to 29.6 mm in thickness. The striking platforms of the blades were categorized based on platform structure and cortex. The most common type consisted of a platform structure (161 blades), followed by those consisting of the cortex (75 blades), two platform structures (57 blades), and several surfaces (27 blades). Additionally, one blade with a linear striking platform was identified. These figures are similar to those observed in the striking platforms of blade cores, suggesting that creating a high-quality striking platform was a crucial step in the blade manufacturing process.

Examining the number, direction, and tip shape of the surfaces removed from the dorsal face of the blade, most blades were flaked in the same direction as the blade cores. This vertical flaking is associated with the crested blade, resulting from the preparation process for continuously releasing blades^[12]. It was confirmed that crested blades were removed from both sides or from the center to both edges and that the dorsal surface of the blade was removed during the preliminary core formation process. However, most ridge blades were adjusted by double-sided flaking.

On the dorsal face of the blades, one to two or Y-shaped ridges parallel to both edges were identified. Typically, two to three blades were removed. In terms of the shape of the blade tips, 322 were found to have short, feathered terminations (less than 50% of the blade length), 11 had hinge terminations (more than 50% of the blade length), 19 had plunging terminations (full length), and 10 had step terminations. The fact that feathered and hinge terminations accounted for more than 95% of the total blades indicates that blade removal was predominantly achieved through vertical flaking^[12,13] (Fig. 6).

2.1.4 Utilization of the hammer in blade technology

77 hammers were excavated from CL 3, primarily identified in the central part of the stone artifact concentration area in the western section of the excavation site. The distribution of these hammers closely matched the locations of blade cores and blades. The raw materials used for the hammers



Fig.6 Blades in CL 3
图6 第3文化层出土的石叶

showed a high proportion of silica and siliceous sandstone, with 30 pieces (41.7%) made from silica, 19 pieces (26.4%) from siliceous sandstone, 14 pieces (19.4%) from sandstone, 6 pieces (8.3%) from gneiss, and 3 pieces (4.2%) from siliceous gneiss. These hammers were believed to be used with raw materials harder than shale, which could be easily found along the nearby river, making them the most commonly used tools at the site. When classified by size, the hammers were categorized as follows: 32 pieces (44.4%) were small, 25 pieces (34.7%) were medium, 11 pieces (15.3%) were large, and 4 pieces (5.6%) were classified as super large.

Hammers of various sizes and shapes appear to have been used to manufacture large blades as well as medium- and small-sized blades.

Additionally, when examining the size of the bulb of percussion on the blades and the condition of the striking platforms, it becomes clear that not only hard hammers but also softer hammers, possibly made from horns, were widely utilized.

However, the proportion of small and medium hammers increased compared to the previous cultural layer, which seems to correlate with the production of medium- and small-sized blades. Among the 72 hammers found, 27 were disc-shaped (37.5%), 20 were long ball-shaped (27.8%), 16 were oval-shaped (22.2%), and 9 were circular (12.5%). Despite these variations, different hammer shapes were evenly distributed across the site. This suggests that the efficiency of the reduction sequence was enhanced by using a variety of hammer types, likely sourced from nearby rivers.

2.2 Correlation between blade and blade tool

The number of tools in CL 3 is significantly smaller compared to the quantity of débitage, likely due to the site functioning as a workshop. Scrapers, end-scrapers, tanged points, and other tools were manufactured from the blades removed from the blade cores, but the formability of most tools, except for the tanged points, was very low.

Although the quantity of tanged points has decreased compared to the previous period, 13 pieces were excavated, making them the most common tool type. Most of the tanged points were made from shale, and their excavation locations overlapped with those of blade cores, blades, and hammers.

The ratio of length to width of the tanged points ranged from 2.5:1 to 4:1. While the length values varied widely, the width values were concentrated within 20 to 30 mm, and the thickness was consistently within 10 mm. This suggests that while the length of the body varied depending on specific circumstances, the width and thickness remained consistent along the tang attached to the base, maintaining a particular size^[14].

Examining the axis of the body based on the position of the tang and the point of the tanged

point, 7 pieces formed a central axis with left-right symmetry, 4 pieces had a slightly right-inclined axis, and 2 pieces had a left-inclined axis (Fig. 7).



Fig.7 Tanged points in CL 3
图7 第3文化层出土的带铤尖状器

3 Characteristics of Blade Technology in CL 3

At SYG-6, AMS dating was conducted using charcoal samples from each cultural layer. The radiocarbon age of CL 2, within the yellowish-brown muddy paleosols, ranges between $17,550 \pm 80$ BP and $20,470 \pm 70$ BP (average age: $18,410 \pm 70$ BP, or 22,467–22,023 cal BP). This corresponds to the initial cold and dry period of the Last Glacial Maximum (LGM). The radiocarbon age of CL 3, also

composed of yellowish-brown muddy paleosols, shows a wide range between $30,360 \pm 350$ BP and $44,100 \pm 1,900$ BP (average age: $35,180 \pm 450$ BP, or $40,172\text{--}39,321$ cal BP). The radiocarbon age of CL 4, consisting of reddish-brown muddy paleosols, ranges between $34,620 \pm 190$ BP and $46,360 \pm 510$ BP (average age: $36,980 \pm 350$ BP, or $41,874\text{--}41,254$ cal BP)^[15,16]. Considering the average radiocarbon age, CL 4 is approximately 2,000 years older than CL 3 (Fig. 8).

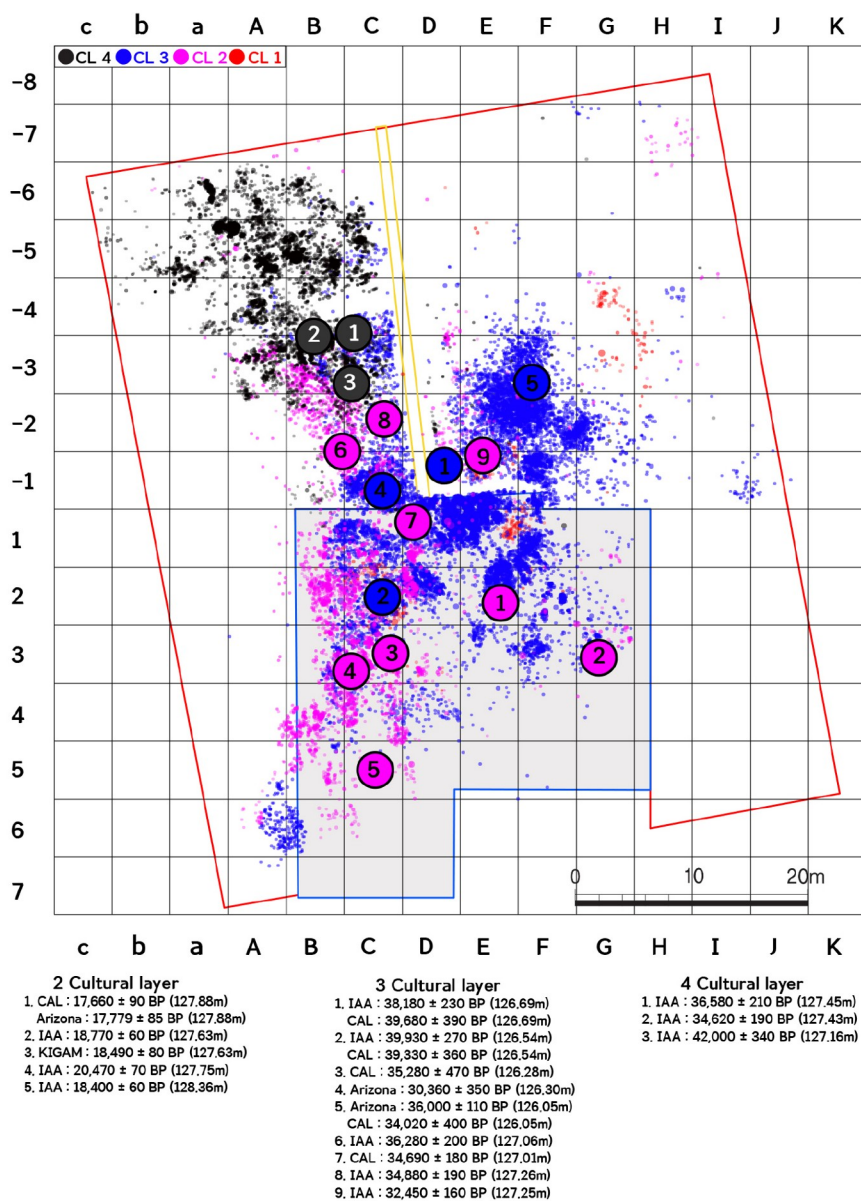


Fig. 8 Radiocarbon dates obtained from charcoals at SYG-6

图8 垂杨介遗址第6地点的碳十四年代测定结果

A notable feature of the Early Upper Paleolithic in Northeast Asia is the reduction in tool size. This characteristic is also observed at SYG-6, where the technological organization gradually transitioned from a large-sized blade tool composition to medium- and small-sized blade tools that coexisted with microblade technology. Therefore, it is essential to examine the diverse technological organizations associated with these changes and how they are represented in CL 3.

3.1 Expansion of medium- and small-sized blade core

The blade core represents the culmination of the Upper Paleolithic people's development of the most effective and economical technology by integrating existing stone tool manufacturing techniques^[17]. It has been observed that the proportion of medium- and small-sized blades increases at several Early Upper Paleolithic sites, a pattern that is also evident in CL 3 of SYG-6.

First, when examining the length of the blade cores, we find that 4 are 5 cm or less, 34 are 10 cm or less, and 9 are over 10 cm. Even assuming that the blade cores found at the site were discarded after the last blade was removed, many of the cores from CL 3 were still suitable for producing medium and small blades around 5 to 10 cm in length.

The blades are categorized by size into small, medium, and large: 109 small blades under 5 cm, 102 medium blades under 10 cm, and 21 large blades over 10 cm. The ratio of medium to small blades is 1:1, with a noticeable decrease in the number of large blades compared to previous cultural layers. These results suggest a correlation between the length of the blade core and the size of the resulting blade (Fig. 9).

The reduction in blade size observed in CL 3 cannot be attributed solely to changes in economic conditions. SYG-6, located in an area rich in fine-grained raw material (shale), suggests that the decrease in blade size may have been driven by increasing demand for medium- and small-sized blades rather than purely economic factors. Despite abundant raw material, relatively few technologies fully exploiting it in the blade manufacturing process have been identified.

Therefore, it is believed that the reduction in blade size was influenced by the heightened need for medium- and small-sized blades, leading to the production of blades of an appropriate size to meet this demand. The stone tool that best exemplifies these characteristics is the tanged point. However, considering that a small number of large blades were still produced, the need for economic activities may also have contributed to the persistence of this technology.

3.2 Emergence of a technological organization related to the microblade core

The microblade culture has been known to have emerged during the Late Upper Paleolithic on the Korean Peninsula, around 25,000 years ago. Remains associated with microblade manufacturing technology are found across the Korean Peninsula, primarily in the upper part of the first soil wedge.

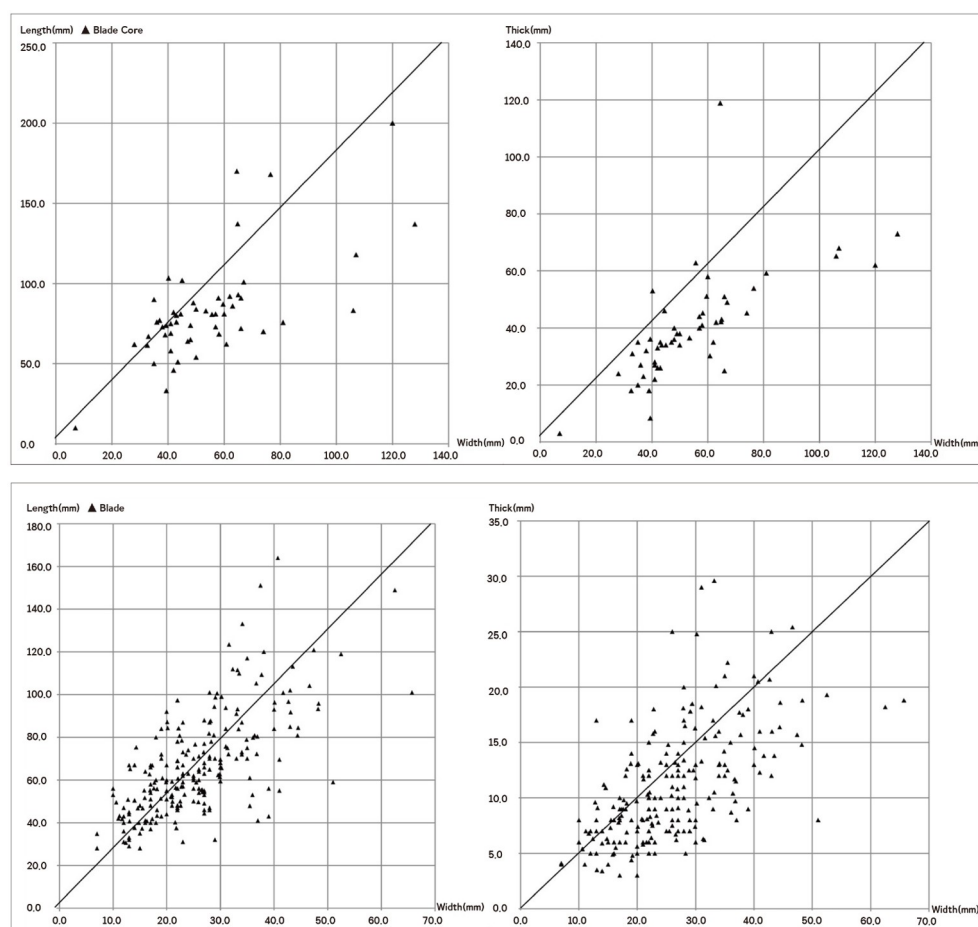


Fig.9 Distribution chart of length, widths, and thickness of the blade core and blade in CL 3

图9 第3文化层出土的石核、石叶的尺寸分布图

CL 3 of SYG-6 is characterized by blade manufacturing technology; however, the discovery of a microblade core, technical flake (ski-type spall), and microblades related to the microblade culture have drawn significant attention. If the dating of CL 3 is accurate, it places these findings within the category of early microblade technology in Northeast Asia^[18]. The technological organization of microblade production typically involved adjusting the core through bifacial or unifacial flaking, then removing the spall to create a striking platform, followed by removing the microblade from the narrow side. However, the microblade core from CL 3 exhibits the technical characteristics of a ‘primitive’ form, where the original shape was used without modification to the core. This primitive form of microblade core, while lacking a fully systematized technical process, utilized a pressure flaking technique for microblade removal.

Although the microblade core and microblade identified in CL 3 were found in small quantities, they are clearly distinct from the small-sized blades produced in the blade industry. In

contrast, CL 2 reveals various systematic technological productions, including those using preforms with bifacial techniques and those using preforms with a flat striking platform and a retouched lower part. These represent a typical form markedly different from the unsystematized techniques observed in CL 3. Recently, there have been increasing instances of microblade cores and small blade cores coexisting in the Early Upper Paleolithic of Northeast Asia [19-21].

The small blade core differs from the central blade technology of CL 3. Like blade production, most small blade cores share the common feature of creating a striking platform, but they were also spalled similarly to microblade cores.

As a result, while the manufactured blade was not a microblade, it closely resembled the technology used for microblade production, suggesting a correlation with microblade manufacturing technology. Notably, since both small blade cores and microblades were produced from the side, it is understood that these technological applications were an extension of the sub-wedge-shaped core technology (Fig. 10).

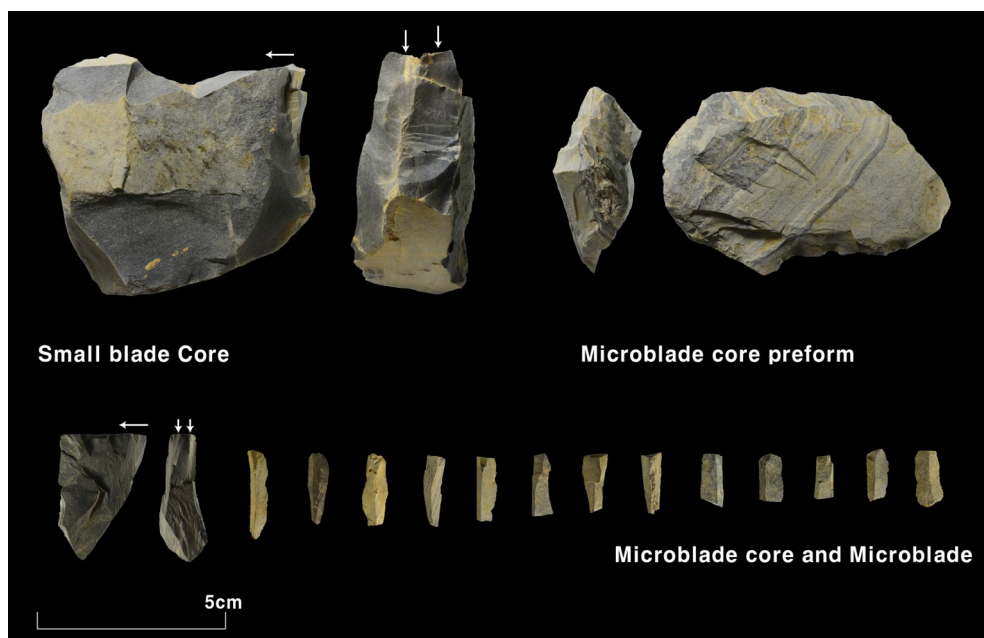


Fig.10 Small blade core and microblade core, microblades in CL 3

图10 第3文化层出土的小石核、细石核及细石叶

Therefore, the microblade core excavated from CL 3 is not a wedge-shaped microblade core typical of the microblade culture that emerged in the Late Upper Paleolithic. Instead, it represents the result of various experimental approaches within the blade production technological organization.

In other words, it appears that attempts were made to produce microblades alongside small

blades within a technological organization designed for creating small- and medium-sized blades. Consequently, CL 3 exhibits a diverse technical spectrum, ranging from a small number of large blades to micro blades, all rooted in the technological organization focused on medium- and small-sized blade production.

3.3 Generalization of vertically flaking blades and tanged points

A tanged point is a stone tool with a pointed end and a ‘tang’, which is presumed to have been fixed into a handle. It is a representative tool of the Upper Paleolithic on the Korean Peninsula^[22]. Numerous tanged points were excavated from SYG-6, and this site provides the oldest absolute dating data for tanged points found on the Korean Peninsula.

A total of 13 tanged points from CL 3 were excavated from the southwest of the site, and their distribution was closely aligned with those of blade cores, blades, and hammers. When comparing the sizes of blade cores, blades, and tanged points, the blades generally had a length-to-width ratio of 2:1 to 3:1, with lengths ranging from 4 cm to 10 cm and widths from 1 cm to 3 cm. The tanged points showed similar size ratios. Compared to CL 4, the size of the tanged points in CL 3 became smaller, likely influenced by the reduction in blade size.

A total of 73 tanged points were excavated from CL 4. This layer, which featured a technological production for producing large- and medium-sized blades, had larger blades than those of CL 3. Consequently, the tanged points from this layer exhibited a distribution of various sizes.

In terms of the blade length ratio to tang length, the blade length was generally greater than the tang length, and in the ratio of tang thickness to tang width, the thickness was consistently thinner than the width. When comparing tang width to shoulder width, tang width showed a similar distribution pattern across all cultural layers. Still, shoulder width was larger in CL 4 compared to CL 3 (Fig. 11).

Most of the angles identified in the blade cores and blades from CL 3 to CL 4 ranged between 80° and 95°, which is ideal for producing long and straight blades. These blades, produced through vertical flaking, became the primary material for tanged points. CL 4 primarily utilized long and straight large blades for tanged point production, with blades having a curved cross-section resulting from plunging being uncommon.

However, unlike the earlier period, CL 3 was capable of producing tanged points even with non-standard blades. This phenomenon seems to be related to the technical and morphological characteristics of the tanged points, which depended on the nature and appearance of the stone tool (Fig. 12).

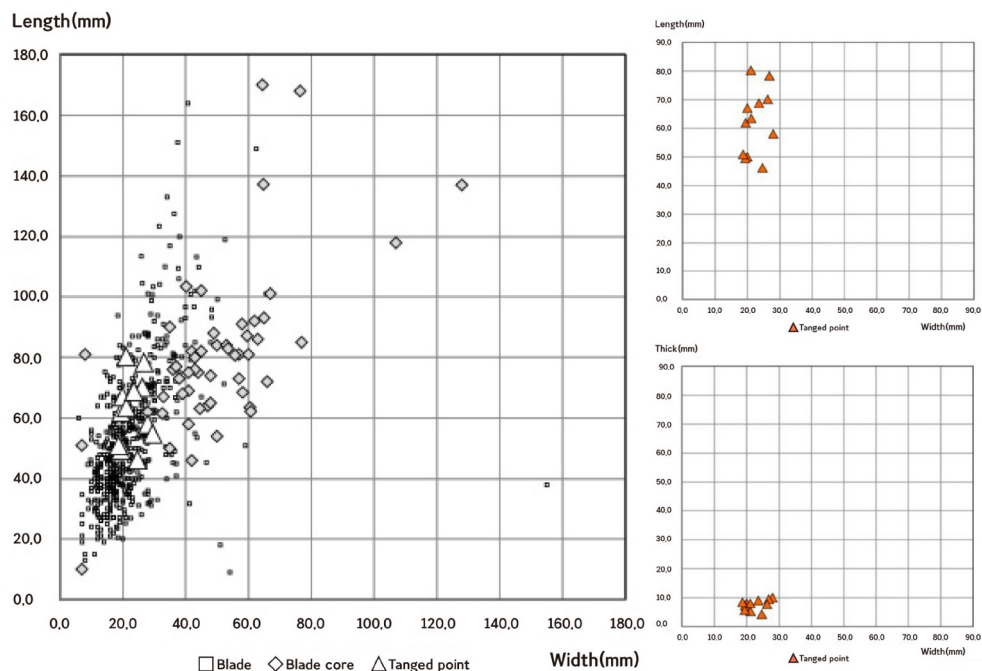


Fig.11 Size comparison of blade, blade core and tanged point

图11 石叶、石核及带铤尖状器的尺寸比较

4 Comparison of Blade Technological Organization at SYG-6

SYG-6 suggests the possibility that blade tool culture began around 42,000 to 40,000 years ago on the Korean Peninsula and serves as a site that showcases the technological organization of the Early Upper Paleolithic. In particular, the stable stratigraphic classification and age differences observed between CL 3 and CL 4 provide crucial data for researching the emergence of blades on the Korean Peninsula and the migration patterns of early modern humans.

AMS dating using charcoal excavated from the site's cultural layers indicates an interval of about 2,000 years between CL 3 and CL 4. The variations between these periods are evident not only in the similarities within their technological organizations but also in their differences. Three primary attributes within the absolute dating data and technological organization of CL 4 are (1) the bifacial flaking system observed in discoid cores (or tools) and remnants of Levallois technology (Fig. 13); (2) the emergence of sub-wedge-shaped core-making techniques; and (3) changes in the techniques according to the size of the blade cores and blades, representing the Early Upper Paleolithic (EUP).

In particular, the characteristics of the blade technological organization and lithic industry of



Fig.12 Artifacts in CL 3
图12 第3文化层出土的石制品

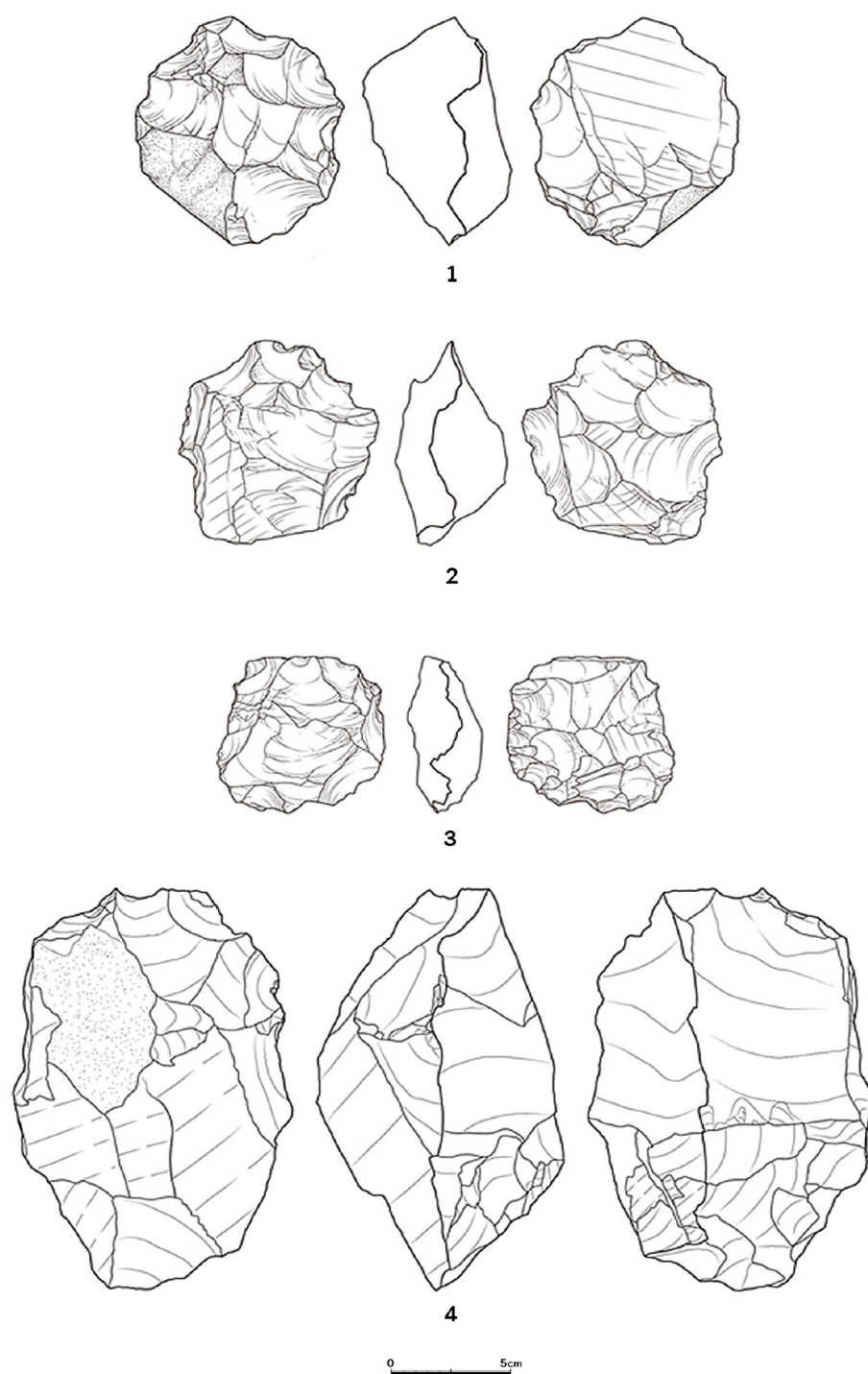


Fig. 13 Discoid core(or tool) of CL 4
图13 第4文化层出土的盘状石核（或工具）

CL 3 and CL 4 illustrate the evolution of blade technology at this site, providing insight into the changes in the existing stone tool manufacturing of modern humans in Northeast Asia. Therefore, the absolute dating and lithic complex of CL 4 reveal aspects of the Initial Upper Paleolithic (IUP) based on early blade technology and the remnants of Levallois techniques. More precisely, while this is not the typical IUP seen in Northeast Asia, it can be considered an early stage of the EUP, with some remnants of Levallois technology^[6,7].

During CL 3, the ratio of medium- and small-sized blades increased, leading to the emergence of standardized blade cores and blades. Additionally, microblade cores and artifacts, absent in earlier layers, were discovered together. Across CL 3 and CL 4, there was a consistent preference for shale as the primary material for crafting stone tools, maintaining a uniform technological production. However, in CL 3, new technical attempts were made, leading to the emergence of new products based on these innovations.

A key aspect of technological changes in the Early Upper Paleolithic in Northeast Asia is the reduction in tool size. In the technological productions that originally produced extra-large blades (15 cm or more) and large blades (10 cm or more), the proportion of medium- and small-sized blades (5 cm to 10 cm) gradually increased. This pattern of change can be observed in CL 3 and CL 4.

When examining the sizes of the stone artifacts, the blade cores from CL 4 are concentrated in the 9 to 12 cm range, with blades measuring 8 to 12 cm. It is also confirmed that extra-large blade cores and blades of 15 cm or more are present in this layer. In contrast, blade cores from CL 3 are predominantly found in the 5 to 8 cm range, with blades measuring 4 to 8 cm. While large blade cores and blades of 15 cm or more are present, their numbers are tiny, totaling fewer than five.

The transition from CL 4 to CL 3 is marked by shifting the sizes of blade cores and blades from medium to large and then back to medium to small. This change is particularly evident with a 4 cm difference in size between the cores and blades. Notably, the tanged point emerges as the stone tool that most clearly reflects these technological advancements, being smaller in size compared to tools from the preceding period.

Among the blade cores of the Upper Paleolithic in Northeast Asia, including Siberia, sub-wedge-shaped cores are particularly notable. Their technological organization is characterized by using a narrow-side striking platform at the proximal end, lower part adjustment through double-sided flaking, and a narrow-side working surface. Sub-wedge-shaped cores are also economically efficient for producing many blades^[8].

Sub-wedge-shaped cores are confirmed in both CL 3 and CL 4 of SYG-6. Most of these cores have one striking platform and one working surface, with straight blades being produced through vertical flaking. The technology for manufacturing blades on the narrow side offers the advantage of stable blade production and is suitable for producing blades of various sizes.

Most of the sub-wedge-shaped cores in CL 3 and CL 4 were large, measuring over 10 to 15 cm, and were primarily used to produce large blades. Judging by the traces of solid blows on the working surfaces, the blades were likely manufactured using hard hammers. Therefore, it is evident that CL 3 and CL 4 featured a large blade production technology using sub-wedge-shaped cores, which were maintained up to CL 3 (Fig. 14).

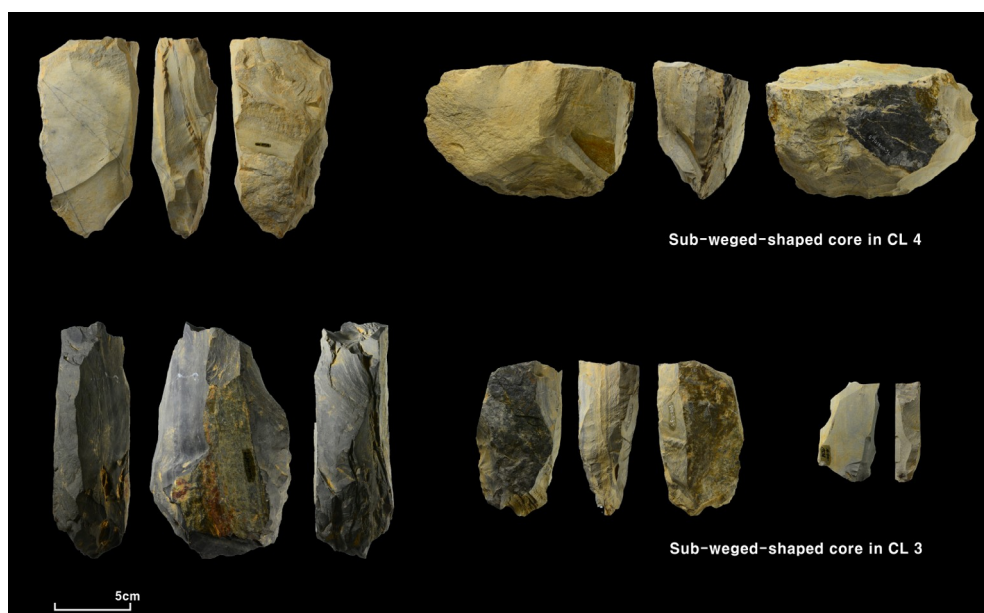


Fig.14 Sub-wedge-shaped cores in CL 3 and CL 4

图14 第3、第4文化层出土的半楔形石核

Silica sandstone pebbles, known for their hardness ranging from 6 to 7, were utilized in the crafting process. These pebbles were tougher compared to shale, which typically has a hardness of 5 and was commonly used as the primary material for making stone tools. The shift towards smaller hammers became more prominent leading up to CL 3. This change likely resulted from the need for a broader range of tools to experiment with different techniques to consistently produce blades of varying sizes, mainly medium- and small-sized blades.

Blades excavated from CL 3 and CL 4 contained traces of various types of hammers. The size and thickness of the blades' striking platforms varied between each cultural layer, with the size of the striking platforms increasing and becoming thicker in CL 4.

These results are related to the size of the blades. To produce large blades, hard hammers were used, resulting in thicker and larger butts^[3,17,23,24]. Therefore, based on the size of the butt and the types of hammers used in CL 3 and CL 4, the change in blade sizes between these two layers can be inferred. It also suggests that different technology may have been used depending on the size of the blades.

While alterations in blade sizes during production were evident, the vertical flaking-based technology remained consistent. This technique, used for creating straight blades, involves either full-length flaking or hinging to shape the blades. The reduction sequence primarily focused on achieving straight blades with tanged points through various attempts and adjustments. However, it is challenging to analyze which specific stone tools these technologies were applied to, as blade tools were not abundant compared to the primary stone tools (Fig. 15).

Through use-wear analysis of the blades found at the excavation site, distinct traces were identified, indicating the use of straight blades on rough and dried leather, as well as other soft animal materials. This observation suggests that the untreated straight blades may have functioned as knives^[25]. Consequently, it is concluded that the current composition of stone tools remains mainly within the workshop category.

The excavation of CL 3 and CL 4 at SYG-6 provides an opportunity to examine the EUP on the Korean Peninsula. The remains that exhibit the characteristics of the EUP on the Korean Peninsula include CL 3 and CL 4 of SYG-6, as well as the remains from Hopyeong-dong, Hwadae-ri, Songam-ri, Galsan-ri, and Chongok-ri (Fig. 16).

The remains from this period share several characteristics. First, blade cores with one striking platform and one working surface are dominant, with blade sizes ranging from 5 to 10 cm. Medium- and small-sized blades were excavated in large quantities, indicating a greater demand for them than large blades.

Second, straight blades were produced from blade cores through vertical flaking. The angles of blade cores and blades excavated from the sites are predominantly concentrated between 80° and 90°. Vertical flaking is a technology well-suited for producing long and straight blades, and it appears that Upper Paleolithic people recognized this and maintained a consistent angle.

Third, straight blades, primarily scrapers, and end-scrapers, were commonly used as tanged points. However, stone tools with standardized shapes, aside from the tanged points, are limited. This suggests that the blade cores and blades in this period exhibited a higher refinement level than earlier, reflecting the medium- and small-sized blade technology. These characteristics hint at parallels with the EUP in Northeast Asia.

5 Conclusion

The discovery of the blade technological organization at SYG-6 offers valuable insights into the origins and advancements of blade tool production in Northeast Asia. Previously regarded as a region lacking early blade industry developments, the Korean Peninsula is now recognized for its distinctive Upper Paleolithic stone tool technology. Excavations at SYG-6 suggest a coexistence of

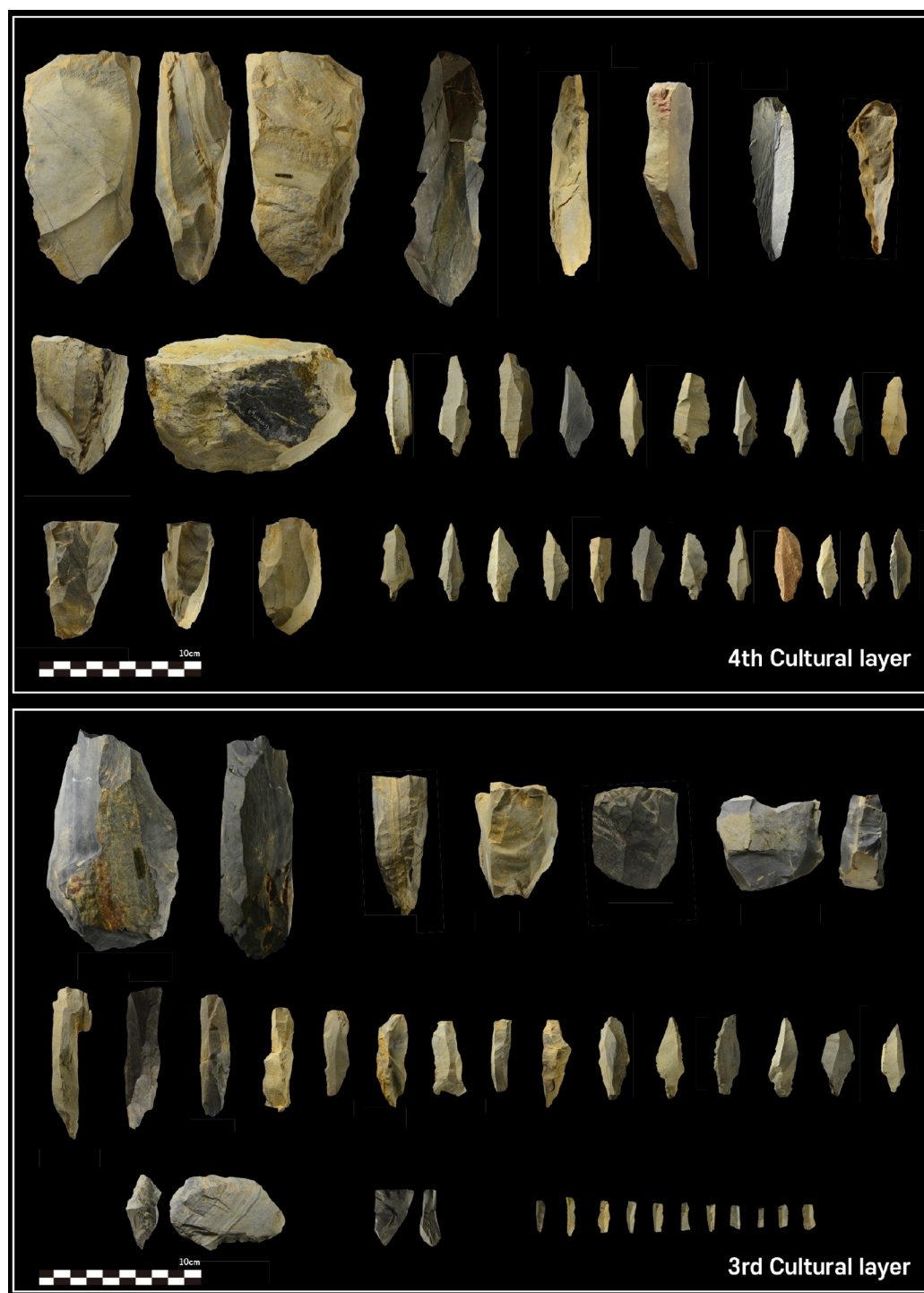


Fig.15 Comparison of CL 3 and CL 4

图15 第3、第4文化层石器比较

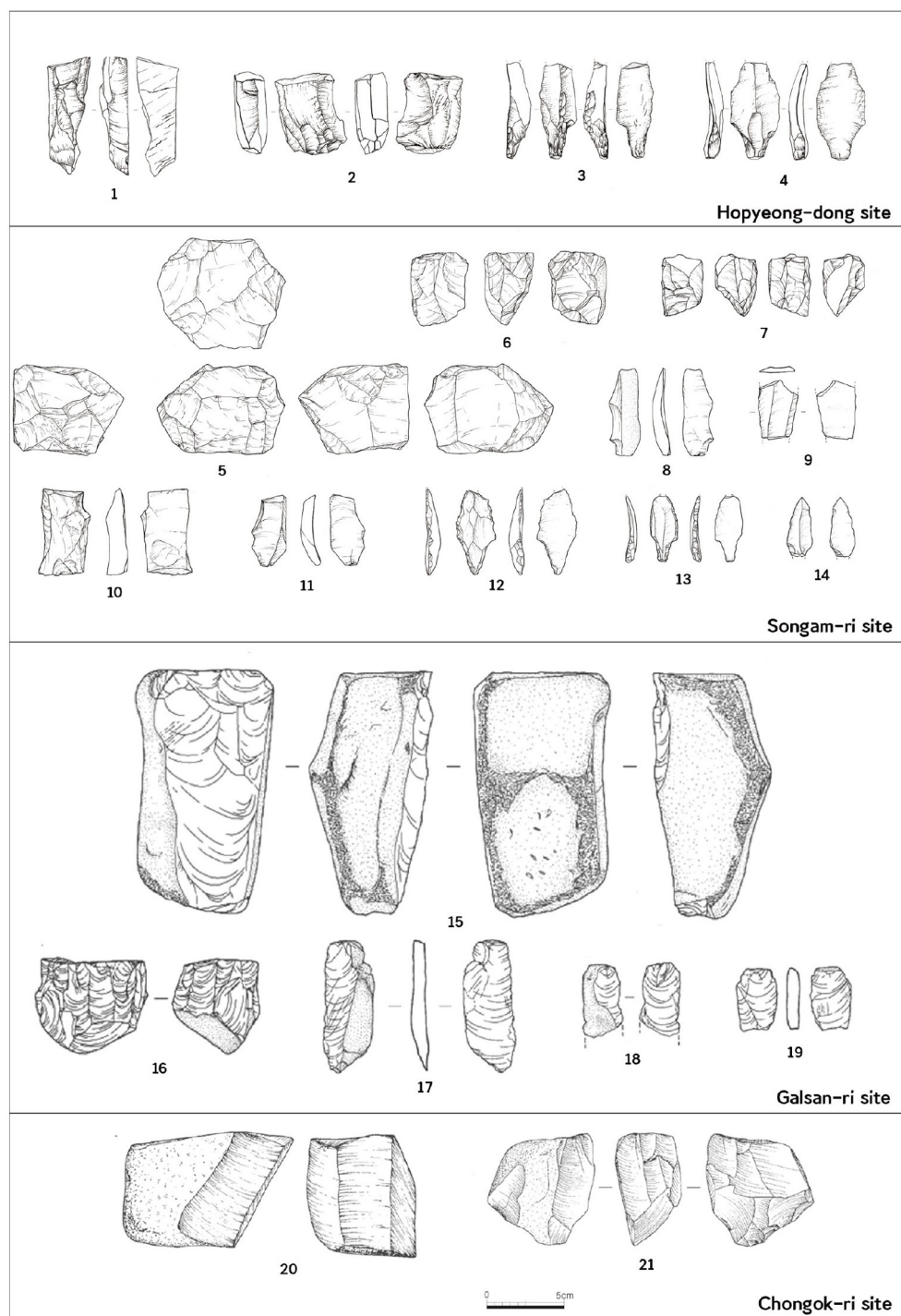


Fig.16 Artifacts excavated from the blade industry in the Upper Paleolithic of the Korean Peninsula

图16 朝鲜半岛旧石器时代晚期石制品

the blade tool industry with the pebble tool tradition, challenging earlier perceptions of technological conservatism in the area.

The technological organization of the stone artifacts in CL 3 reflects the characteristics of the Early Upper Paleolithic on the Korean Peninsula. Analysis of the lithic complex in this layer indicates that it may have served as a workshop for acquiring blades and making tanged points, similar to CL 4. Key features of the stone tool technological production include advancements in medium- and small-sized blades, the development of basic microblade technology, consistent use of sub-wedge-shaped cores for blade production, and the vertical flaking technique, particularly for creating tanged points. The most significant transformation in blade technology within CL 3 and CL 4 was in the size and technical complexity of the blades, driven by the demand for smaller- and medium-sized artifacts rather than a shift in economic activities in the Suyanggae area. This evolution is best exemplified by the tanged points, which became smaller and more refined than earlier periods.

The stone artifacts representing the EUP on the Korean Peninsula include those from CL 3 of SYG-6, as well as from sites such as Hopyeong-dong, Hwadae-ri, Songam-ri, Galsan-ri, and Chongok-ri. The standout characteristics during this period include changes in blade size, an increase in the number of blades with standardized forms, and the use of medium- and small-sized blade technology. This pattern mirrors that seen at Late Paleolithic sites in Northeast Asia. However, the Late Paleolithic relics on the Korean Peninsula face limitations, as stone tools using blades have not been excavated sufficiently to allow for detailed examination.

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A study of Early Upper Paleolithic blade production in the third cultural layer at Suyanggae Locality VI, Republic of Korea

LEE Heon-Jong¹, JANG Hyeong-Gil², LEE Yung-Jo³

1. Department of Archaeological and Cultural Anthropology, Mokpo National University, Mokpo, Korea 58554;

2. Chungbuk Research Institute of Cultural Heritage, Cheongju, Korea 28353;

3. Institute of Korean Prehistory, Cheongju, Korea 28763

Abstract The blade technological organization identified at Suyanggae Loc.VI(SYG-6) provides valuable insights into the origins and development of the blade tool industry in Northeast Asia. Before the excavation of the 3rd and 4th cultural layers at SYG-6, the Korean Peninsula was considered a conservative area where the early stages of the blade tool industry had not appeared. However, it is now recognized as a region with a unique Upper Paleolithic stone tool technology in East Asia, where the blade tool industry coexisted with the pebble tool tradition. The technological organization of the artifacts from CL 3 reflects the characteristics of the Early Upper Paleolithic on the Korean Peninsula. Analysis of the lithic complex in this layer suggests that it may have functioned as a workshop for acquiring blades and making tanged points, similar to CL 4.

Key features of the stone tool technology include the expansion of medium and small blades, the emergence of primitive microblade technology, the continued use of sub-wedge-shaped cores for blade production, and the application of vertical flaking for blades, particularly in the creation of tanged points. The most significant changes in the blade technological organization between CL 3 and CL 4 involve shifts in blade size and the complexity of the associated technology, including the selection of raw materials. These changes reflect the increasing demand for artifacts utilizing small- and medium-sized blades and may be tied to shifts in economic activities in the Suyanggae sites. This pattern is characteristic of a typical Early Upper Paleolithic variant with a blade industry. The characteristics observed at Late Upper Paleolithic sites are closely aligned with those of CL 3 at SYG-6.

Keywords Suyanggae Locality VI; EUP(Early Upper Paleolithic); blade; blade production; tanged point; microblade; microblade production