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RESEARCH ARTICLE

The Early Upper Paleolithic of Korea: A chronological review

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Abstract

Despite the continuous reporting of radiometric chronology of lithic assemblages in the Korean peninsula, systematic evaluation of reliable radiocarbon (^{14}C) dates and discussion on the lithic technological variability have not been adequately presented. This paper attempts to address the issue reviewing the available data on the Early Upper Paleolithic (EUP) of Korea, with a focus on ^{14}C chronology and lithic technology. Also, these recent advances in Paleolithic studies in Korea provide interesting aspects of the transition to Upper Paleolithic (UP) technology in East Asia. The transition to the UP is characterized by two key developments: the emergence of blade technology and tanged points, and the use of quality raw material that had been previously disregarded. Reliable ^{14}C dates published recently indicate that this transition began around 43,000–40,000 cal BP. We propose that the emergence of the UP tradition on the Korean peninsula can be explained by focusing on the mobility, regional exchange networks and population dynamics of hunter-gatherers rather than the continuing resort to the simple unidirectional dispersal.

1. Introduction

Radiocarbon (^{14}C) dating has been widely applied to building Upper (or Late) Paleolithic (UP) chronologies in the Korean peninsula.[1] A small amount of literature published in English has offered a general sketch of the chronology and technological characteristics of the Korean Paleolithic: the onset of the UP in Korea is marked by the persistence of new tool types, such as tanged points along with blades. Many studies (Bae 2010; Bae and Bae 2012; Lee GK 2012; Lee HW 2016; Seong 2008, 2009) favor a conservative position that the blade industry emerged around 35,000 cal BP. Chang (2013), for example, proposes that the duration of tanged points as spanning from 35,000 to 15,000 cal BP, while Seong (2015, 99) suggests that the emergence of tanged point assemblages goes back to 40,000–35,000 cal BP. Previous studies, however, do not adequately embrace recently published radiocarbon dates of which we now have more than 200 available for the Paleolithic in Korea (Kim and Seong 2022; Seong 2019).

As such, recent advances in Paleolithic research in Korea have yielded more UP assemblages with earlier and secure radiocarbon dates including those from Yongsujaeul, Songam-ri, and Hajin-ri (Suyanggae Loc. VI), which suggests that the Early Upper Paleolithic (EUP) emerged as early as 43,000–40,000 cal BP. Consequently, we can now re-examine the chronology of the Paleolithic transition and to consider its implications with regard to the modern human dispersal in a broader

[1] As Seong and Bae (2016) argue, the notion of the Middle Paleolithic in the context of Korea and adjacent East Asia is dubious at best, and we prefer the two, rather than three, period chronology of Early and Late. Nonetheless, we still use the concept Upper Paleolithic interchangeably with Late Paleolithic as in the context of its abbreviated terms as the Early Upper Paleolithic (EUP).

context of East Asia. Moreover, it is notable that EUP assemblages marked by tanged points and blades/blade cores were made of fine-grained raw materials, such as silicified tuff and shale, that had previously been largely disregarded.

In what follows, we present a detailed review of the characteristics of EUP lithic assemblages based on recent archaeological excavations in Korea. First, we evaluate the reliability of each radiocarbon date as an index proxy for the occupation at the UP sites. Second, we propose that the onset of the UP in Korea is characterized by the emergence of new tool types, such as tanged points along with blades, and changes in raw material use (Bae and Bae 2012; Chang 2013; Lee GK 2012; Lee HW 2016). Nevertheless, we also note that the use of locally available vein quartz and quartzite persisted throughout the Paleolithic. Subsequently, the implications of the dispersal of modern humans in the region are also to be discussed.

2. Material and Methods

Radiocarbon dating has provided a basis for discussing the emergence of the UP tradition (Bae et al. 2013; Bae 2002; Chang 2013; Lee 2016; Lee et al. 2017; Seong 2011) and even fluctuations in population on the Korean peninsula (Kim and Seong 2022; Seong 2019; Seong and Kim 2022). Given that radiocarbon dates may not directly associated with the timing of human occupation, it is essential to evaluate each of these dates before using them to establish a chronology (Graf 2009; Morisaki et al. 2019; Pettitt et al. 2003; Seong 2011, 2019).

As previously outlined (Kim and Seong 2022; Seong 2011), (1) dates derived from soil samples are excluded as they are not directly associated with human occupation, and (2) those with large error margins (greater than 1000) are out of consideration. (3) Dates only obtained from stratigraphic sections with no archaeological remains are disregarded. (4) In cases where many dates are available, as in the case of Hajin-ri, we focus our discussion based on those dates that are correlated with each other and those directly associated with the lithic scatters. (5) The evaluation is further enhanced by the inclusion of other chronological indicators, such as optically stimulated luminescence (OSL) dates or Aira-Tn (AT) tephra remains that originated from southern Kyushu, Japan, at 30,000–28,000 cal BP (Kudo and Kumon 2012; Smith et al. 2013; Tsutsumi 2012; Yi et al. 1998).

Our study is primarily based on the typological and technological characteristics of Korean EUP assemblages (Figure 1), focusing on blades, blade cores, and tanged points as the major components. The use of high quality lithic raw materials, which have been largely unused previously, is also considered. Eight lithic assemblages from six sites in Korea are highlighted in this study (Table 1). Furthermore, the diversity of lithic assemblages is also discussed by including assemblages of EUP dates with no or very few blades and tanged points (Table 1:1–15). For example, as shown in Table 1, the highlighted EUP assemblages are characterized by high quality lithic raw materials such as siliceous shale, (silicified) tuff, or hornfels, while the remaining assemblages are dominated by artifacts made of locally abundant vein quartz and quartzite.

The EUP cultural horizons presented here share a common geologic context: dark brownish layers with high degree of clay-silt deposition, indicating a similar depositional environment during the Late Pleistocene. The cultural horizons also contain so-called “soil cracks” above the artifact concentration level, which are widely observable at the Late Pleistocene deposits throughout the peninsula. Geomorphological and soil micromorphological analyses strongly suggest that these common features are well correlated with an aeolian depositional environment (Jeong et al. 2013).

3. Results

3.1. Evaluation of radiocarbon dates and Korean EUP chronology

Table 2 lists the radiocarbon dates from Hajin-ri and other EUP sites in Korea. Hajin-ri, located about 3.5 km from the better-known Paleolithic site of Suyanggae, was excavated from 2013 to 2015 (Institute

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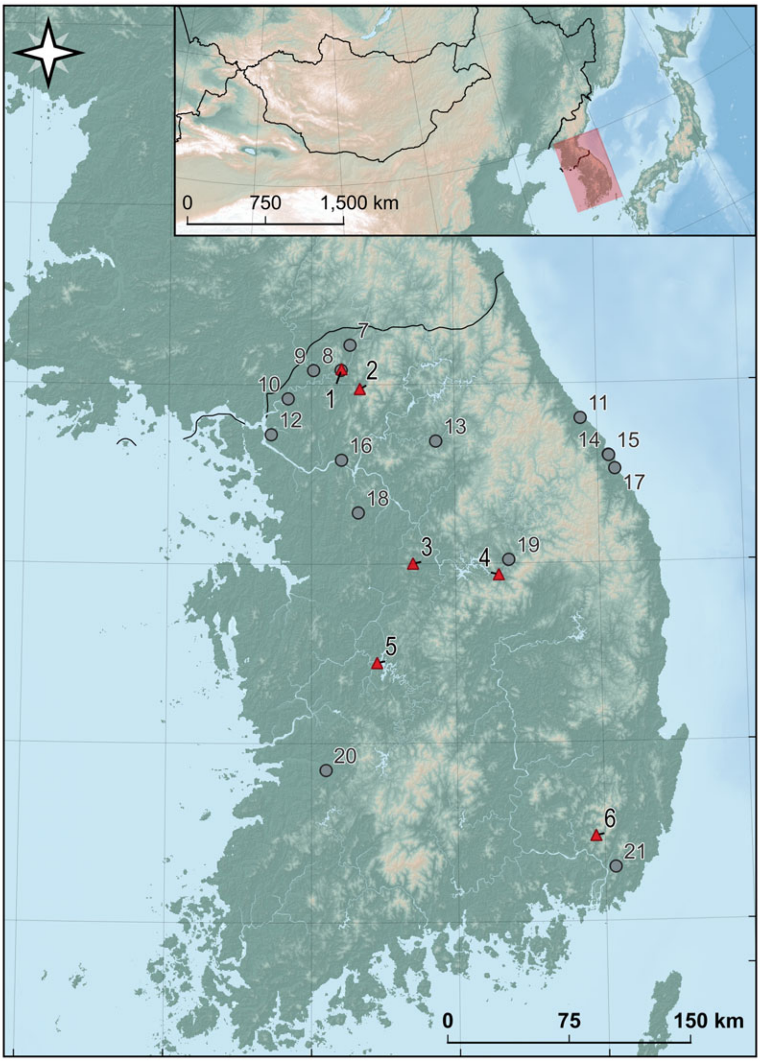

Figure 1. *The approximate locations of Korean EUP sites discussed in text. Site names with numbers are listed in Table 1. Red triangles represent sites yielding blades and tanged points, while gray circles indicate those without blades or tanged points.*

of Korean Prehistory 2018). Excavators collected more than 40,000 stone artifacts among which about 35,000 were made of siliceous shale from four horizons. Only the lower two horizons (CH 3 and 4) were dated to the EUP. A total of 2253 blades and 153 blade cores were collected from the lowest horizon (Hajin-ri 4), and 589 blades with 61 blade cores were unearthed from horizon 3 (Hajin-ri 3). The lower two horizons yielded a considerable number of tanged points, all made of siliceous shale.

A total of 31 dates from the Hajin-ri assemblages have already been reported by Kim et al. (2021). However, an archaeological examination of the reliability of the dates is not yet fully presented. Among the 15 dates from Hajin-ri 3, we believe that one exceptionally old date (44,100±1900 BP [AA-105133]) and the unacceptably late date (30,360±350 BP [AA-105134]) are considered as outliers that do not correlate with other dates and are excluded from further consideration. Another date (33,220±240 BP [CWd-?]), that lacks a laboratory number, provenance, and the material of the dated sample, was removed from our analysis. Radiocarbon dates from the lowest horizon, Hajin-ri 4, span

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Table 1. *Lithic assemblages relevant to the early UP tradition (note the numbers 7–21 are those with no or only a few blades)*

No.	Assemblage/cultural horizon	No. of artifacts	Major lithic raw material	Blade/tanged point	Source
1	Yongsujaeul CH 1	1310	Silicified tuff (98.9%)	Yes	GICH 2016
2	Hwadae-ri CH 2	3709	Vein quartz (94.8%) and Tuff (4.8%)	〃	IGA 2005
3	Songam-ri CH 1	256	Vein quartz (80.5%) and Siliceous shale (10.2%)	〃	IKP 2014
4	Hajin-ri CH 3	7470	Siliceous shale (81.9%)	〃	IKP 2018
	Hajin-ri CH 4	10,883	Siliceous shale (94.8%)	〃	
5	Yongho-dong CH 2	662	Vein quartz (74.3%) and Tuff/Hornfels (8.6%)	〃	HUCM 2017
	Yongho-dong CH 3	975	Vein quartz (47.7%) and Tuff/Hornfels (19%)	〃	
6	Gorye-ri	7908	Mudstone/Hornfels	〃	Chang 2013, 2016
7	Sangsa-ri CH 2	219	Vein quartz (90.4%)	N/A	GRICP 2013
	Sangsa-ri CH 3	139	Vein quartz (100%)	〃	
8	Neulgeori CH 2	2790	Vein quartz (68.4%), tuff (14.3%) and obsidian (10.07%)	Yes	GCHRC 2016
9	Samgeo-ri CH 1	984	Quartzite and vein quartz (86.3%), tuff (12.9%)	2 retouched blades	BICH 2019
10	Geumpa-ri (3rd layer)	1544	Quartzite and vein quartz (90.6%)	N/A	ICPHU 2006
11	Anhyeon-dong CH 1	115	Quartzite and vein quartz (97.4%)	〃	YICP 2011
12	Dongpae-ri II CH 4	2	Vein quartz (100%)	〃	GICP 2010
	Dongpae-ri II CH 1	2	Vein quartz (100%)	〃	
13	Yeonbong CH 2	85	Vein quartz (96.5%)	〃	GRICP 2007
14	Gigok CH 2	1098	Vein quartz (97.5%)	〃	GRICP 2005
	Gigok CH 3	118	Vein quartz (94.9%)	〃	
15	Mangsang-dong CH 1	885	Quartzite and vein quartz (81%)	〃	GRICP 2009
16	Deokso (3rd layer)	87	Quartzite and vein quartz (64.4%)	〃	USWM 2008
17	Wolso CH 2	700	Quartzite and vein quartz (83%)	〃	YICP 2010
18	Yujeong-ri CH 3	184	Quartzite and vein quartz (70.7%)	〃	JIA 2022
19	Gunanggul (3rd layer)	40+	Dominated by limestone	〃	CBNU 1991; IKP 2007, 2013, 2015
20	Palbok-dong CH 3	147	Vein quartz (40.8%) and rhyolite (55.8%)	Blades only	JRICH 2019
21	Sasong-ri CH 1	74	Tuff (75.7%)	〃	GCHRC 2018

Table 2. Calibration and evaluation of radiocarbon dates from Korean EUP sites, with all dated materials being charcoal

#	Assemblage	Stratigraphy	^{14}C age BP	Lab no.	Depositional context	Evaluation*	cal BP (95.4%)**	Source
1	Hajin-ri 3	9th, Yellowish brown (10YR 5/6) clay-silt	39,930 ± 270	IAAA-140154	Little associated with artifact concentration	2	**43,899–42,746**	IKP 2018; Kim et al. 2021
2			33,220 ± 240	CAL-?	Context missing	1		
3			39,330 ± 360	CWd-140196-1	Little associated with artifact concentration	2	**43,188–42,423**	
4			40,070 ± 380	CWd-140196-2	〃	2	**44,111–42,765**	
5			44,100 ± 1900	AA-105133	Oldest date	0		
6			35,280 ± 470	CWd-140196-3	Associated with lithic scatters	3	**41,260–39,526**	
7			30,360 ± 350	AA-105134	Youngest date	0		
8			34,020 ± 400	CWd-140199	Associated with lithic scatters	3	**39,995–37,630**	
9			36,000 ± 1100	AA-105135	〃	3	**42,485–39,230**	
10			38,180 ± 230	IAAA-140155	Little associated with artifact concentration	2	**42,524–42,134**	
11			39,680 ± 390	CWd-14097	〃	2	**43,888–42,544**	
12			34,690 ± 180	IAAA-150632	Associated with lithic scatters	3	**40,371–39,416**	
13			34,880 ± 190	IAAA-150633	〃	3	**40,535–39,585**	
14			32,450 ± 160	IAAA-150639	〃	3	**37,143–36,324**	
15			36,280 ± 200	IAAA-150631	〃	3	**41,753–40,971**	
16	Hajin-ri 4	13th, Reddish brown (5YR 5/4) clay-silt	36,580 ± 210	IAAA-150636	〃	3	**41,917–41,191**	
17			34,620 ± 190	IAAA-150637	Youngest date	0		
18			42,000 ± 340	IAAA-150638	Oldest date	0		
19			36,600 ± 360	CWd-160054	Associated with lithic scatters	3	**42,053–41,045**	
20			37,190 ± 320	CWd-160055	〃	3	**42,250–41,440**	
21			34,870 ± 540	CWd-160056	〃	3	**41,179–39,104**	
22			42,860 ± 370	IAAA-150635	Samples obtained from the primary sediment section	1		

(*Continued*)

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Table 2. *(Continued)*

#	Assemblage	Stratigraphy	^{14}C age BP	Lab no.	Depositional context	Evaluation*	cal BP (95.4%)**	Source
23			46,360 ± 510	IAAA-150634	〃	1		
24	Yongsujaeul	4th, Brown (7.5YR 5/4)	24,060 ± 130	KGM-OTg160226	Not associated with the cultural horizon	1		GICH 2016
25		clay-silt	42,080 ± 600	KGM-OTg160225	〃	1		
26	Songam-ri	2nd, Dark brown (7.5YR 3/4)	32,300 ± 160	IAAA-120001	Associated with only a few of lithic scatters	3	**36,985–36,251**	IKP 2014
27		clay-silt	33,190 ± 160	IAAA-120002	〃	3	**38,750–37,130**	
28	Hwadae-ri	3rd, Dark brown (7.5YR 3/4) clay-silt	31,200 ± 900	SNU03-340	〃	3	**38,386–34,079**	IGA 2005
29	Yongho-dong	3rd-a, Dark brown (7.5YR 3/3) clay-silt	38,500 ± 1000	SNU-?	Associated with lithic scatters	3	**44,205–41,476**	HUCM 2017

*The numbers in the evaluation column represent the following: 0 – out of consideration; 1 – rejected; 2 – need further consideration; 3 – accepted, respectively.
**The dates were calibrated using OxCal v4.4.4 (Bronk Ramsey 2009) with IntCal 20 (Reimer et al. 2020).

42,000 to 39,000 cal BP, if we do not accept another exceptionally old outlier (42,000±340 BP [IAAA-150638]) and 2 dates from a non-archaeological context (#22, 23).

The most controversial part of the Hajin-ri chronology is some reversal of dates from CH 3 and CH 4, as five dates from CH 3 (#1, 3, 4, 10, 11 in Table 2) are earlier than many dates from the CH 4. These dates were obtained from the relatively lower part of the slope deposit where only a few artifacts were collected, so we cannot rule out the possibility that they are not directly associated with the human occupation. Nevertheless, with the exception of the five questionable dates, the rest of the radiocarbon dates from CH 3 are slightly later than those from the CH 4. As a result, the Hajin-ri 3 dates concentrate around 40,000 cal BP, if we reject the earliest and latest, and archaeologically unacceptable dates as shown in Table 2, and the horizon 4 dates are close to 43,000–41,000 cal BP.

Yongsujaeul was excavated between 2011 and 2013 (Gyeore Institute of Cultural Heritage 2016). Two artifact-bearing horizons at Yongsujaeul yielded blades, blade cores, and tanged points. The lower horizon, a brown clay layer, yielded blades and 4 tanged points, along with approximately 1300 artifacts made dominantly of silicified tuff (1296 artifacts). The horizon has two radiocarbon dates from charcoal samples: 24,060±130 BP (KGM-OTg160226) and 42,080±600 BP (KGM-OTg160225). Given the location of the artifact concentration between the two, the excavators suggested that the timing of the lower horizon could be dated between the two radiocarbon dates (GICH 2016, 777). Due to the large gap between the two dates, we cannot determine exactly when the site was occupied. While the two dates are not included in the calibration and graphical summary, we still believe that the lower horizon of Yongsujaeul with evidence of blade core reduction technology is relevant to the discussion of EUP chronology in Korea.

The lower horizon (dark brown clay layer) of Hwadae-ri provided a total of 3709 chipped stone artifacts (Institute of Gangwon Archaeology 2005). While most (3516) were made of locally available vein quartz, finer-grained silicified tuff, or porphyry according to the excavation report, was also used to make formal UP artifacts including endscrapers and scrapers. Three tanged points, also made of silicified tuff, were made on flakes, not blades. The cultural layer was radiocarbon dated to 31,200±900 BP (SNU03-340) from a charcoal sample recovered from the layer characterized by typical Upper Pleistocene soil cracks. An OSL date of 30,000±1700 BC is also available for the stratification unit contain this cultural horizon at Hwadae-ri. No true blades and blade cores were recognized, while large tanged points were made on flake blanks rather than blades.

Three tanged points, made of silicified tuff (or 2 shales and 1 rhyolite according to the excavation report), were recovered along with 253 chipped stone artifacts including blades and blade cores from Songam-ri (IKP 2014). Two radiocarbon dates were available, 32,290±160 BP (IAAA-120001) and 33,130±160 BP (IAAA-120002), dated from charcoal samples from the cultural horizon.

Multiple cultural horizons were identified by the excavators at Yongho-dong (Hannam University Central Museum 2017). The 3rd horizon yielded 975 and the 2nd produced 662 stone artifacts including tanged points along with a radiocarbon date of 38,500±1000 BP (lab number unknown) from a charcoal sample recovered between the two horizons.

At Gorye-ri, a number of artifacts were recovered from the light brown clay layer, including at least 15 tanged points and large blades exceeding 20 cm in length (Chang 2013, 2016). While no radiocarbon dates are available, it can be noted that many of the collected artifacts were found in the same deposit that yielded traces of AT tephra, which was blown from southern Kyushu ca. 30,000–28,000 cal BP (Chang 2013; Smith et al. 2013; Tsutsumi 2012; Yi et al. 1998). But this evidence is contextual at best because the discovery of AT tephra is typically not confined but diffused across the deposit. No formal excavation report is available, and we do not know exactly how many artifacts were collected and their precise archaeological context. Nonetheless, tanged points and blades were predominantly made of mudstone (or hornfels) in the assemblage.

In their discussion of the EUP tanged points from Korea, Morisaki et al. (2019, 94) argued that the Yongho-dong radiocarbon date is uncertain, whereas those from Hwadae-ri and Songam-ri, spanning 38,000 to 33,000 cal BP are reliable and secure. However, the most recent information about the onset of the UP tradition in Korea, as the Hajin-ri excavation provides (IKP 2018; Kim et al. 2021), we can

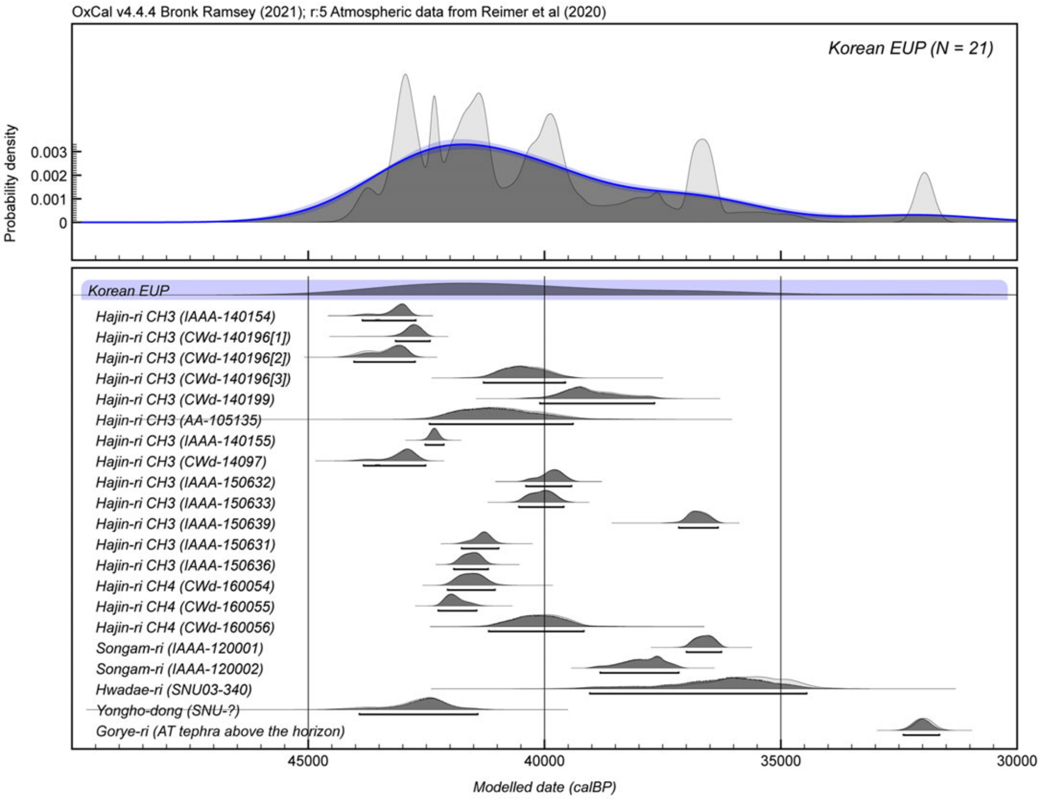

Figure 2. *A graphical summary (generated by using the KDE_model command in OxCal) of calibrated radiocarbon dates from the EUP assemblages in Korea.*

accept the Yongho-dong date comparable with those from Hajin-ri 3 and 4, with the AT tephra obtained above the Gorye-ri artifact horizon.

As a result, we have at least 20 reliable radiocarbon dates out of total 29 dates from six EUP assemblages (Table 2). These evidence all indicate that the Late Paleolithic (UP) tradition, characterized by blade technology using fine-grained raw materials, emerged by 43,000 cal BP (Figure 2) according to the Bayesian modelled age (Bronk Ramsey 2017).

Additionally, there are lithic assemblages yielding radiocarbon dates within the EUP range (Tables 11–15; Table S1), yet the quantity of blades and tanged points unearthed is minimal. These are characterized by the local abundance of coarse-grained quartzite and vein quartz, with only a few small, retouched tools present. As illustrated in Table 1, most assemblages comprise a limited number of artifacts, with fewer than 1000 items. However, there are four exceptions, including the collection of blades from Neulgeori CH 2, Samgeo-ri, Palbok-dong, and Sasong-ri.

The EUP assemblage from the dark brown layer (CH 2) of the Neulgeori site is composed of total 2790 artifacts, including 398 silicified tuff and 281 obsidian artifacts. While the report provides two radiocarbon dates, 31,590±290 BP (SNU13-377) and 33,060±290 BP (SNU13-378), they were dated on charcoal samples recovered 20 cm lower than the artifact scatters (Sujin Kwon, personal conversation, 2021). So, the dates are at best dubious in considering the age of the cultural horizon. The same close scrutiny is needed for the Samgeo-ri assemblages (the lower horizon) and dates (36,300±210 BP and 40,370±340 BP, with no lab numbers).

Given the small number of artifacts dominated by local quartzite and vein quartz, with only a few exceptions with dubious radiocarbon dates, our discussion of the transition to EUP technology focuses

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Table 3. *Technological characteristics of blade production from EUP sites in Korea. (Data based on blade cores described in the excavation reports)*

		Yongsujaeul	Songam-ri	Hajin-ri 3	Hajin-ri 4	Total
Blank	Pebble	3		5	11	19
	Chunk		2	6	6	14
	Flake			3	14	17
	Unknown	10		39	118	167
	Total	*13*	*2*	*53*	*149*	*217*
Striking platform	Natural cortex				3	3
	Plain surface			10	10	20
	Flake scars	13	2	43	136	194
	Total	*13*	*2*	*53*	*149*	*217*
Striking direction	Unidirectional	6	1	39	79	125
	Bidirectional	7	1	8	70	86
	Multidirectional			6		6
	Total	*13*	*2*	*53*	*149*	*217*
Blade dorsal scars	Crested	25	1	47	176	249
	Unidirectional	170	3	485	1863	2521
	Bidirectional	27	2	40	204	273
	Natural cortex	19	3			22
	etc.			6	10	16
	Total	*241*	*9*	*578*	*2253*	*3081*

on lithic assemblages with a considerable number of blades and/or tanged points made of silicified shale or tuff with reliable radiocarbon dates.

3.2. Blade technology

Korean EUP assemblages are characterized by the common raw material use: blades and blade cores were predominantly made of quality raw materials, i.e., silicified shale, tuff or hornfels rather than quartzite and vein quartz, as shown in Table 1. Silicified tuff was widely used and is locally available around Yongsujaeul, while Hajin-ri and Songam-ri toolmakers relied heavily on siliceous shale. Silicified tuff and siliceous shale, however, share common properties and they are indistinguishable to the naked eye (Seong 2003).

Blade technology is closely related to the use of high-quality raw materials. While about 30% of the artifacts collected from Yongsujaeul, Hwadae-ri, and Songam-ri are flakes, whether they are complete or broken, at Hajin-ri 3 and 4, and Yongho-dong flakes account for 60–70% of the total assemblage. However, if we only consider flakes of quality raw materials, the percentages drop to 5–15% at Hwadae-ri, Songam-ri, Hajin-ri, and Yongho-dong. In other words, high-quality raw materials were more likely to be used for producing blades rather than regular amorphous flakes.

As shown in the Table 3, most blade cores have a detectable platform that was likely prepared deliberately. For example, except for only three blade cores of the total, most of the striking platforms for 149 artifacts from Hajin-ri 4 are characterized by flake scars. Specimens from Gorye-ri may also indicate the sophisticated preparation processes for blade production (Chang 2013). While cores from Yongsujaeul, Songam-ri and Hajin-ri 4 show similar frequencies of unidirectional and bidirectional in terms of directions of blade detachment, artifacts from Hajin-ri 3 show more unidirectional specimens (39 out of 53 total cases, or 74%) than bidirectional (8, or 15%) and multidirectional (6, or 11%). However, the directions of core reduction as shown by scars on the dorsal surface of the blades, which 82%, or 2521 of 3081 specimens have, reveal same directions as they were detached from cores.

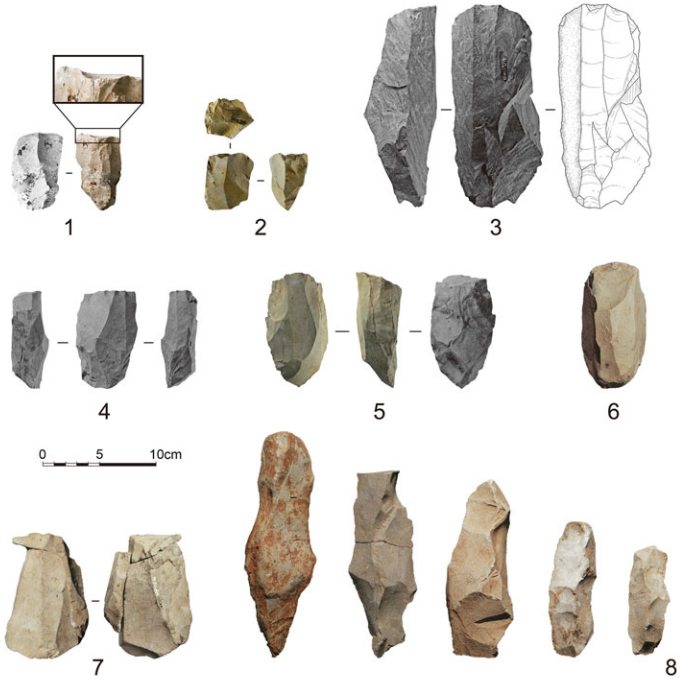

Figure 3. *Blade cores cores from Yongsujaeul (1, with facetted striking platform), Songam-ri (2), Hajin-ri 3 (3), Hajin-ri 4 (4–5), and Gorye-ri (6–7) and large-crested blades from Gorye-ri (8). All images are taken from the excavation reports, except for those from Gorye-ri (6–8; Daegu National Museum [DNM] 2005).*

Crested blades are often considered to be the first detached pieces in the process of systematic and continuous blade production (Chang 2013, 2016). As shown in Table 3, 47 (8.13% of a total of 578 blades) and 176 (7.81% of a total of 2253 blades) crested blades were collected from Hajin-ri 3 and 4, respectively (IKP 2018, 514, 630). According to the excavation reports, 25 crested blades (10.37% of a total of 241 blades) were unearthed at Yongsujaeul (GICH 2016, 307).

It is also notable that blades exhibit considerable size variability, as illustrated in Figures 3 and 5. While small and thin artifacts were identified in several assemblages, large blades exceeding 10 cm in length were also not uncommon, particularly from Hajin-ri 4 (Figure 5, green circles). Notably, the Gorye-ri site also yielded exceptionally large blades and blade cores, in addition to numerous large crested blades (Figure 3: 6–8).

3.3. Tanged points

More than 400 tanged points have so far been recognized in the southern Korean peninsula (Park et al. 2023). Almost all the tanged points among the EUP sites discussed in this paper (N=92) were made of quality raw materials. It is noteworthy that no tanged points were observed to have been manufactured from vein quartz or quartzite, the predominant lithic raw materials present in Early Paleolithic assemblages in Korea. Also, no obsidian tanged points have been reported, while two obsidian stemmed points, from Sam-ri and Suyanggae, have been more accurately described as bilateral points. This may indicate a different and more intensive reduction and recycling of obsidian artifacts, although further data and analysis are required to support this claim.

Tanged points were likely mounted on the tips of spears, and many artifacts are found with either the tip or tang broken (Lee and Sano 2019; Park et al. 2023; Seong 2008). Among the four tanged points

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Table 4. *Technological attributes of tanged points*

Attribute	Blank			Tang location	Tang retouch direction		Tang side retouch
Assemblage	Blade	Flake	Chunk	Proximal end	Ventral to dorsal	Both	Both
Yongsujaeul (4)	4			4	3	1	4
Hwadae-ri (3)		3		3		3	3
Songam-ri (3)	3			3	3		3
Hajin-ri 3 (11)	9	1	1	11	10	1	11
Hajin-ri 4 (65)	64		1	65	42	23	65
Yongho-dong (2)	2			2	2		2
Total 88	82	4	2	88	60	28	88

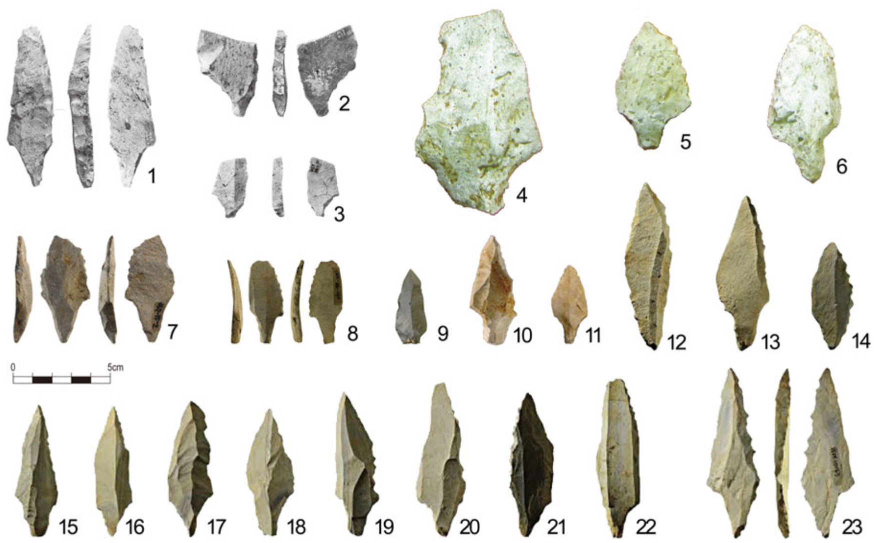

Figure 4. *EUP tanged points from Yongsujaeul (1–3), Hwadae-ri (4–6), Songam-ri (7–9), Yongho-dong (10–11), Hajin-ri 3 (12–14) and Hajin-ri 4 (15–23).*

from Yongsujaeul, three were broken (Figure 4:2–3). In contrast, Hajin-ri 4 contains many complete artifacts (Figure 4:15–23), and almost two-thirds of the 61 tanged points were found without damage. Also, retouching along an edge often exposes denticulated forms, which may have enhanced hunting efficiency by accelerating the bleeding of the hunted (Figure 4:5, 7–8, 10, 13–15, 19–23; Seong 2008).

Several studies have focused on manufacturing techniques or processes (Chang 2016; Kim 2017; Lee 2011; Lee and Sano 2019; Otani 2016, 2019; Park 2013). From a technological perspective, tanged points were typically made by retouching on blades (Table 4). Blade blanks are dominant (82 out of total 88 tanged points, 93%), indicating that tanged point manufacture is directly related to blade technology, although there are a few flake blanks, such as those from Hwadae-ri (Figure 4:4–6). While two tanged points from Yongho-dong have been described as using elongated flake blanks (HUCM 2017), it is more likely that blade blanks were used, as their ridges on the dorsal surface run in parallel (Figure 4:10–11).

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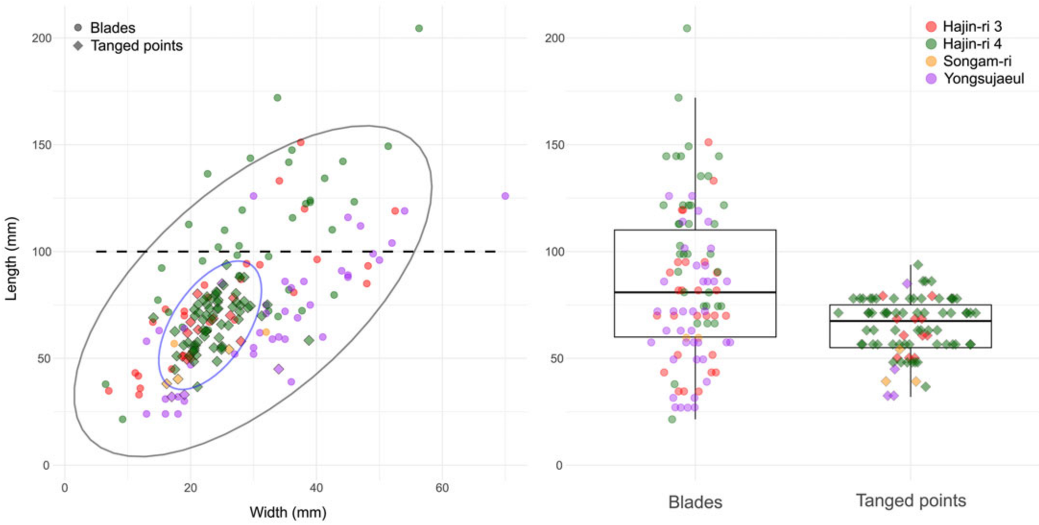

Figure 5. *The scatter plot of blade and tanged point size (left) and the box-jitter plot of blade and tanged point length (right) based on the reported data (103 blades and 82 tanged points out of 185 total). The data presented are described in Table S2.*

All 88 specimens have retouches on the proximal ends to prepare tangs, while retouches in the normal direction (from ventral to dorsal surface) and on both sides of the retouch are predominant. Blades with sharp distal ends and parallel sides were preferred, and the proximal end was heavily retouched to prepare a tang. As essential elements of the technology, including the use of high-quality raw materials, the selection of suitable blanks, and the application of retouching to the proximal end, remain constant.

Figure 5 shows the size variability (maximum length and width) of blades and tanged points from the four EUP assemblages mentioned above. Blade size is widely distributed, ranging from approximately 20–200 mm in length and 10–60 mm in width, while tanged points are concentrated between 25–100 mm length and 15–30 mm width. Also, variability in terms of size of both tanged points and blades: Yongsujaeul specimens are significantly smaller than Hajin-ri 4 artifacts, as shown in Figure 5.

4. Discussion

4.1. Summary of recent progress in Korean Paleolithic research

Recent excavations of important Paleolithic sites in Korea have provided a solid ground for the emergence of the EUP in Korea and adjacent East Asia with such typical artifacts as tanged points, blades, and blade cores along with reliable dates ranging from 43,000 to 35,000 cal BP.

First, tanged points along with blades/blade cores are important components of EUP assemblages. Two lower EUP horizons at Hajin-ri yielded more than 80 tanged points, which effectively marking the earliest such examples in Korea. Although we must be cautious in designating a single artifact type as the diagnostic artifact of the UP tradition, the use of distinctive raw materials to produce the tanged points highlights their importance. Tanged points, with their implications for primary use as spear tips with multiple functions (Lee and Sano 2019; Park et al. 2023; Seong 2008, 2009), imply that the UP transition was also likely associated with behavioral strategies focused on hunting and high mobility.

Second, recent excavations and an adjusted chronology based on reliable radiocarbon dates push the onset of the blade technology in Korea back to 43,000 cal BP, and possibly as early as 45,000 cal BP. Studies from eastern Eurasia (Gladyshev et al. 2012; Goebel et al. 1993; Kuzmin 2007; Li et al. 2013,

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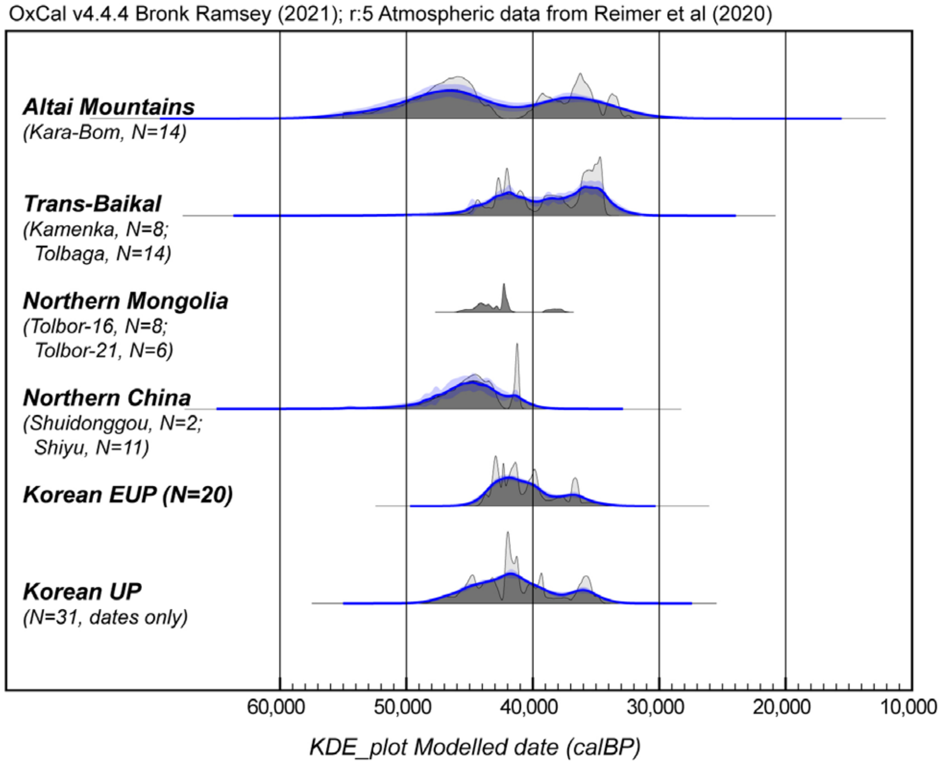

Figure 6. *A comparison of the kernel density estimation (KDE) of reliable radiocarbon dates from Korean EUP (Table 2) assemblages and selected well-known Eurasian IUP-EUP sites (radiocarbon dates and their references are described in Table S3).*

2019; Morgan et al. 2014; Rybin et al. 2020, 2023; Yang et al. 2024; Zwyns et al. 2019) suggest that the onset of the Initial Upper Paleolithic, or IUP, may have occurred around 50,000–45,000 cal BP, while there is still uncertainty regarding the correlation with other radiometric dating (e.g., Keates and Kuzmin 2015). As shown in Figure 6, multiple radiocarbon dates including those from Hajin-ri and Yonghodong are not much later than those from the earliest UP assemblages of the southern Siberia, Mongolia, and northern China (Izuho et al. 2019; Madsen et al. 2001; Morgan et al. 2014; Rybin et al. 2023; Yang et al. 2024; Zwyns et al. 2019).

Third, it is noteworthy that the use of locally available vein quartz and quartzite persisted throughout the UP (Bae and Bae 2012; Bae 2010; Lee 2016; Seong 2009, 2015). In short, blades and tanged points were dominated by fine-grained materials, while coarse-grained materials widely available locally were still widely used in the production of other artifacts. We can also note that even the assemblages with blades and tanged points contain a significant number of artifacts made of quartzite and vein quartz, the major lithic raw material for the Korean Paleolithic industries. This contrasting pattern of raw material use may indicate that the UP transition is not a sudden shift of full-scale replacement, but it was more like a process of adaptation to the local environment and available resources including lithic raw materials.

4.2. Implications for modern human dispersal

We can say that the emergence of the UP tradition was a global phenomenon, since it was likely associated with the dispersal of anatomically modern humans. Current understanding overwhelmingly

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focuses on the southward migration of modern humans into Korea, favoring a late chronology based on dates available a decade ago (Bae 2010; Bae and Bae 2012; Bae et al. 2013; Keates 2010). But the issue is more complicated than it seems. This is largely because we simply do not have an adequate fossil record to discuss the issue, especially given the huge gap in archaeological and paleoanthropological information from North Korea.

Recent advances in Korean Paleolithic research strongly suggest that the transition occurred around 43,000–40,000 cal BP, which is comparable to early dates from northern latitudes such as Transbaikal, Mongolia and North China aside from a few earlier dates from southern Siberia (Figure 6) from which researchers assume the UP tradition and modern humans dispersed southward. To go beyond the pinpointing and reconstruction of linear migration routes, we propose to emphasize the mobility strategies of the last glacial foragers in northern latitudes, including Korea. The spread of the blade industry probably reflects the expansion of the mobility range into unknown territories and environments, which can be viewed as adaptive and evolutionary processes (sensu Kelly and Todd 1988).

Mobile hunter-gatherers, regardless of where they dispersed from, would have had suitable adaptive strategies to secure not only food resources but also suitable lithic raw materials in new environments (Seong 2007). These mobility strategies were also based on regional and superregional social networks and a marriage universe through which information and rare items such as high-quality raw materials and symbolic artifacts were exchanged (Layton et al. 2012; Pearce 2014; Seong and Kim 2022; Whallon 2006; Wobst 1974). Such an extensive social network can be inferred from the population dynamics of modern hunter-gatherers, which are characterized by a preference for partners who ensure future cooperation rather than close kin (Hill et al. 2011, 2014; Kramer et al. 2017; Smith et al. 2016, 2018).

We disagree with the suggestion that two cultural groups can be distinguished by associating one local group with quartzite and vein quartz and another group with blade technology as they dispersed from the north (Bae 2010, 2021). The assumption that different cultural groups used different lithic assemblages, sometimes referred to as core/flake *vs.* blade industries (Lee 2018) is also dubious at best. These differences are more likely related to diverse adaptive strategies, including the use of locally available vein quartz in the production of expedient strategies (Binford 1979; Parry and Kelly 1987), while formal tools were made from quality raw materials (see also Li et al. 2016; Zhang et al. 2022). High residential and logistical mobility, coupled with an extensive social network, likely enabled the flow of nonlocal raw materials from distant sources (Fitzhugh et al. 2011; Kim and Seong 2022; Kuzmin 2017, 2019; Seong 2019; Whallon 2006).

5. Conclusions

Given the early emergence of UP tradition in northeast Asia and ample discussion about the IUP (Izuho et al. 2021; Kuhn 2019; Kuhn and Zwyns 2014), recent advances in Korean Paleolithic research provide an interesting point on the emergence of the UP in the far eastern part of Eurasia. A number of radiocarbon dates from the recently excavated Hajin-ri and other sites indicate that the technological transition to the UP began around 43,000–40,000 cal BP. Tanged points are important components of EUP assemblages and they were typically made of blades. As such, the early emergence of the UP technology is characterized by blades and tanged points made of quality raw materials. Another important point is the continued reliance on locally available vein quartz to make expedient tools and artifacts, which suggests that the transition to the UP tradition is not compatible with the perspective focusing on simple unidirectional north-south migration causing a complete shift. Rather, we highlight high logistical and range mobility and far-reaching social networks of mobile hunter-gatherers during the last glacial period to explain the spread of EUP assemblages. This explanation for the transition in lithic technology is further supported by the use of quality raw materials such as silicified tuff, shale and hornfels, which were hitherto unused and locally unavailable at most sites.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/RDC.2024.138

Data availability. The raw data used for the figures and tables in this article are available in the individual tables and in the supplemental tables (Table S1 to S3).

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Author contributions. Chuntaek Seong: Conceptualization, Methodology, Data analysis, Writing. **Donghee Chong:** Conceptualization, Methodology, Data analysis, Writing.

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.

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