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The nature of the Early to Late Paleolithic transition in Korea: Current perspectives

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ABSTRACT

Various models have been presented to explain the transition from the Early to Late Paleolithic in Korea, a major behavioral change that occurred during the Marine Isotope Stage (MIS) 3–2 transition (~40–25 ka). The three primary models to explain the transition are: 1) a slow *in situ* evolutionary model, where indigenous foragers slowly developed blade and microblade technologies with little to no outside influences; 2) a north-south [migration] model, where migrations from the north by blade and microblade utilizing foraging groups and from the south by traditional core and flake utilizing foragers occurred; and 3) a migration/trade interaction model where migrations occurred from the north, possibly from the south, but at least some of the foragers in the region interacted in some type of trade interaction sphere. These models are reviewed here, along with a presentation of key Korean sites that date to the MIS 3–2 transition.

1. Introduction

In eastern Asia, the transition from the Early to Late Paleolithic is only slowly becoming better realized (Gao and Norton, 2002; Norton and Jin, 2009; Norton et al., 2009). Norton and Jin (2009) recently reviewed the East Asian record (restricted to China, Korea, and Japan) and found that more evidence for the saltational model of modern human behavior exists in the north, while the archaeological record in the south appears to support more of a gradualistic model. The saltational model, as defined by Norton and Jin (2009: 247) states that "between 50 and 40 kya modern human behavior appears suddenly and as a "package"; that is, the entire range of traits appeared more or less simultaneously". The gradualistic model suggests that modern human behaviors appeared intermittently, gradually building up over long periods of time (Norton and Jin, 2009). The earliest evidence for the transition to the Late Paleolithic (e.g., introduction of blade and microblade technologies) appears in northern China, Korea, and Japan. It is currently not clear about when the evidence of modern human behavior begins to appear in Southeast Asia (including southern China). However, there is currently an absence of evidence of blade and microblade technologies in Late Pleistocene Southeast Asia (Norton and Jin, 2009). Interestingly, the archaeological record currently conflicts with some genetic studies that argue for modern humans arriving initially in southern China and dispersing northward (for discussion, see Su et al., 1999; Jin and Su, 2000; Karafet et al., 2001; Shi et al., 2005; Norton and Jin, 2009; Di and Sanchez-Mazas, 2011 and below). It should be noted that Shea (2011) recently suggested that paleoanthropologists may be overemphasizing the presence/absence of blades/microblades to argue for presence/absence of "modern human behavior". Indeed, recent studies in Africa (Johnson and McBrearty, 2010) and the Levant (Shimelmitz et al., 2011) indicate that blade technology may actually well predate the evolution of modern *Homo sapiens* (McDougall et al., 2005). Although Shea (2011) was referring to the western Old World, it is interesting that blades/microblades do not appear in Southeast Asia, including southern China, but that some genetics studies argue for the initial appearance of modern humans in that region and later migrations into northern China (e.g., Su et al., 1999; Jin and Su, 2000; Shi et al., 2005). If it is true that modern humans arrived first in southern China and they had what might be considered "modern human" behavior, then they clearly did so without needing to rely on blade stone tool technology. This may provide indirect support for Shea's (2011) suggestion that paleoanthropologists may be overstating the relationship between blade stone tool technology and "modern human behavior."

There is a paucity of clear evidence of a distinct "Middle" Paleolithic in eastern Asia (Ikawa-Smith, 1978; Norton, 2000; Gao and Norton, 2002; Bae, 2002b; Norton et al., 2009; Seong, 2009). Indeed, KD Bae (2002b: 473) writes "[f]ollowing Western archaeological practices, the Korean Paleolithic is divided into three substages, the Lower, Middle, and Upper Paleolithic… [However], there are few clear changes in stone industries between so-called Early and Middle Paleolithic industries, bringing into question the

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utility of these designations." In this paper we utilize a two stage classification system: Early and Late Paleolithic (Gao and Norton, 2002). It should be noted however that many Korean (and Chinese and Japanese) Paleolithic specialists continue to use a three stage cultural sequence (Lower, Middle, Upper) indiscriminately without clearly defining what they mean by a distinct "Middle Paleolithic" (but see Yoo, 2007). Although it is beyond the scope of the current paper to evaluate this question, we strongly recommend this is a question that should be taken up by Korean (and Chinese and Japanese) Paleolithic researchers in the future. In other words, the questions should be framed as: 1) "exactly how is the "Middle" Paleolithic being defined in eastern Asia?"; and 2) "is it useful to continue to apply the western three stage Paleolithic theoretical framework to the eastern Asian record?" (Gao and Norton, 2002; Norton et al., 2009; Norton and Jin, 2009; Seong, 2009; for discussion about theoretical aspects of what modern human behavior actually represents see recent papers by; McBrearty and Brooks, 2000; Henshilwood and Marean, 2003; Mellars et al., 2007; Shea, 2011). In answer to the above questions, a detailed evaluation by Gao and Norton (2002) drew the conclusion that: 1) the "Middle" Paleolithic is currently poorly defined in eastern Asia; and 2) the three stage Paleolithic cultural sequence (Lower, Middle, Upper) developed for the western Old World, particularly Europe, is currently not an appropriate model to use for the eastern Asian record (see also Norton et al., 2009; Seong, 2009). Thus, in this paper we use the two stage (Early and Late) Paleolithic sequence.

The nature of the Early to Late Paleolithic transition in Korea is still poorly understood (Seong, 2006, 2009; KD Bae, 2010; Lee, in press). In general, the Korean Early Paleolithic is represented by a combination of core and flake tools, usually produced on locally available quartz and quartzite, with the occasional presence of a small bifacial component (Bae, 1988; Norton, 2000; Yoo, 2007). Good examples of the latter artifact composition are many of the sites located in the Imjin-Hantan River Basins (Bae, 1988, 1994, 2002a; Norton, 2000; Norton et al., 2006; Yoo, 2007; Norton and Bae, 2009). One of the interesting aspects of the Korean Late Paleolithic is that some stone toolkits continue to be comprised of typical Early Paleolithic core and flake tools, while other lithic assemblages are comprised of blade and microblade stone tools (KD Bae and Kim, 2003; Norton et al., 2007a; Seong, 2007, 2009; KD Bae, 2010; Lee, in press). This interesting characteristic of the Korean Late Paleolithic has been explained by indigenous behavioral evolution (Seong, 2006, 2009). For instance, Seong (2009: 417) recently stated that "Late Paleolithic technological characteristics emerged ca. 40,000–30,000 BP, but not until the onset of the OIS 2 did formal artifacts, such as blades and blade tools, became [sic] predominant in lithic assemblages. This change is viewed as a slow, evolutionary process that eventually culminated in the Late Paleolithic transition." The other major proposed model to explain this behavioral transition in Korea is a combination of different foraging groups emigrating from Siberia and southern China (aka "North-South model") (KD Bae, 2010).

The focus of this synthesis is to evaluate these two models. In particular, we review the nature of the archaeological and hominin fossil records during the marine isotope stage (MIS) 3–2 transition (~40–25 ka), particularly in its paleoenvironmental setting (Fig. 1; Table 1). Based on current evidence in Korea, this is the period when the Early to Late Paleolithic transition occurs and a time when the climate shifts from a relatively warm to a colder environment. The environmental framework is particularly important because neither of the earlier models (but see Seong (2008) for some discussion) appeared to place much importance on it. Although it is difficult to necessarily associate a specific hominin taxon with a specific stone tool type [e.g., see difficulties with trying to determine who the first stone toolmakers were (Toth and Schick, 2009)], it will still be a useful exercise to see if pertinent variation is present in the hominin fossil record. The same applies to the behavioral record. In other words, does the transition from the Early to Late Paleolithic represent a "slow, evolutionary process" as proposed by Seong (2009: 417) or a combination of different foraging groups dispersing into the Korean Peninsula from the north and the south as proposed by KD Bae (2010)? What should be evident from this review is that currently, the Korean hominin fossil record offers relatively little to addressing this transition, while the Paleolithic record indicates that a major behavioral transition occurred during this period. Both Seong (2009) and KD Bae (2010) are correct in a number of aspects of their models. However, we add a few more relevant points which we believe will help to better understand the nature of the Early to Late Paleolithic transition in Korea.

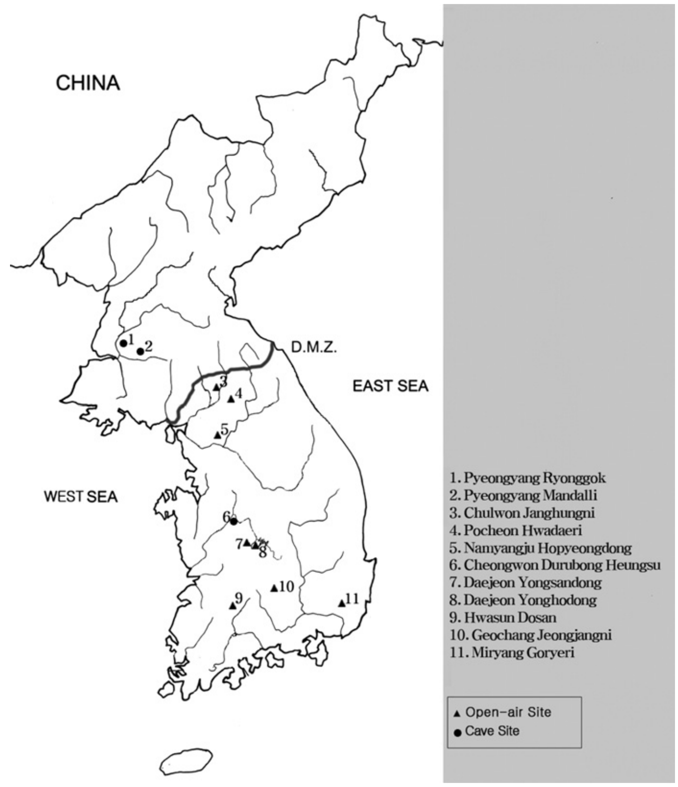

Fig. 1. Locations of sites mentioned in text.

2. Paleolithic archaeology record

> [T]he boundary of the beginning of the Upper Paleolithic [in Korea] is still not clear, because no definite agreement has been reached on the definition of Upper Paleolithic industries. Introduction of blade technology is indisputable evidence of the beginning, as in other parts of the world. However, many stone industries without any blade technology and assemblages comprised of a mixture of blade stone tools with traditional core and flake artefacts made on quartz and quartzite materials are observed in layers which are considered to date from the latest Late Pleistocene, younger than 40,000 BP. Accordingly, assemblages classified as 'Upper Paleolithic' are diverse in their composition. (KD Bae, 2010: 104)[1]

[1] In this context, KD Bae's (2010) definition of the Upper Paleolithic is synonymous with our Late Paleolithic.

Table 1
Korean sites discussed in text. Location # represents site position in Fig. 1.

Location	Name	Open Air/Cave	Sample Position	Age (dating method)[a]	Artifacts	Hominin Fossils	Reference
1	Ryonggok	Cave		500–400 ka (TL); 48–46 ka (U-series)		Yes	Jun et al., 1986; Norton, 2000; CJ Bae, 2010
2	Mandalli	Cave		20,000 BP[b]		Yes	Kim et al., 1985; KD Bae, 2010
3	Janghungni	Open Air	Light brown layer	24,200 ± 600 (AMS)	Yes	No	Choi et al., 2001
			Light brown layer	24,400 ± 600 (AMS)			
4	Hwadaeri	Open Air	1st cultural layer	22,000 ± 1000 (OSL)	Yes	No	Choi, 2007
			2nd cultural layer	33,680 ± 1009 (calibrated AMS); 30,000 ± 1700 (OSL)			Choi and Ryu, 2005; Choi, 2007
			3rd cultural layer	39,000 ± 1400 (OSL)			Choi, 2007
5	Hopyeongdong	Open Air	Brown sandy clay (northeastern part of the site)	16,190 ± 50 (AMS)	Yes	No	Hong and Kim, 2008
				16,900 ± 500 (AMS)			
				16,600 ± 720 (AMS)			
				17,500 ± 400 (AMS)			
				17,400 ± 400 (AMS)			
				15,000 ± 1100 (OSL)			
			Brown sandy clay (western part of site)	21,100 ± 200 (AMS)			
				22,200 ± 200 (AMS)			
				23,900 ± 400 (AMS)			
				24,100 ± 200 (AMS)			
			Dark brown	27,600 ± 300 (AMS)	Yes	No	
				27,500 ± 300 (AMS)			
				29,200 ± 900 (AMS)			
				30,000 ± 1500 (AMS)			
			Colluvial	8 dates between 34,500 ± 800 and 31,000 ± 500 (AMS)	one vein quartz core		
6	Heungsu (Turubong)	Cave		12,100 ± 130 (AMS)	No	Yes	Seoul National University AMS laboratory, n.d.
				10,390 ± 80 (AMS)			
7	Yongsandong	Open Air	Brownish clay layer	24,430 ± 870 (AMS)	Yes	No	JRICH, 2007
8	Yonghodong	Open Air	Light brown layer	38,500 ± 1000 (AMS)	Yes	No	Han, 2002
9	Dosan	Open Air	Sandy clay containing bedrock fragments (first)	61,380 ± 3040 (OSL)	Yes	No	Lee and Kim, 2009; Lee, in press
			Yellowish brown sandy clay (second)	53,000 ± 4110 (OSL)			
			Dark brown clay with soil wedges (third)	46,080 ± 1720 (OSL)			
			Light brown clay (fourth)	28,100 ± 1950 (OSL)			
10	Jeongjangni	Open Air	Dark brown soil layer	25,700 ± 150	Yes	No	Gyeongnam Development Institute, 2004
				29,200 ± 900			
				29,760 ± 300			
				28,600 ± 300			
				26,300 ± 1100			
				29,340 ± 700			
				3060 ± 40			
				22,100 ± 300			
				33,500 ± 1200			
11	Goryeri	Open Air		Below the AT tephra (~25–22 ka)	Yes	No	Jang, 2001; Kim et al., 2002

[a] Abbreviations: TL: thermoluminescence; U-series: uranium-series; AMS: accelerator mass spectrometry; OSL: optically stimulated luminescence.
[b] Unclear from publication, but likely traditional C14 dating analysis.

In general, the Korean Late Paleolithic can be divided into two cultural stages: 1) an initial blade technology that appears sometime between 40 and 35 ka; and 2) around 25 ka microblades begin to appear in the archaeological record (Fig. 2; Seong, 2009; KD Bae, 2010). Because the focus of our paper is the MIS 3–2 transition, we restrict our discussion to sites that have been dated to around 40–25 ka. Reviews of Korean Late Paleolithic sites that date to around or postdate the Last Glacial Maximum appear elsewhere (e.g., KD Bae and Kim, 2003; Norton et al., 2007a; Seong, 2007, 2008, 2009; KD Bae, 2010; Lee, in press).

A handful of sites currently exist in Korea that have been dated to the MIS 3–2 transition by AMS and/or optically stimulated luminescence (OSL) dating methods (KD Bae, 2002b, 2010; KD Bae and Kim, 2003; Seong, 2009; CJ Bae and Kim, 2010; Lee, in press). These include, but are not restricted to Yonghodong, Hwadaeri, Hopyeongdong, Yongsandong, Janghungni, Jeongjangni, and Goryeri, all located in present day South Korea. Many other Late Paleolithic sites have been identified throughout South Korea, though most still do not have secure chronometric dates or have been intensively studied (e.g., see Lee, in press of his recent review of the Paleolithic of the Honam region of southwestern Korea where more than 300 Paleolithic sites were found). As we have noted elsewhere (e.g., Norton, 2000; CJ Bae, 2010), due to the sociopolitical climate of North Korea, it is difficult to synthesize recent paleoanthropological findings identified in that region. Although it falls outside the scope of the present paper, we do discuss the important North Korean Late Paleolithic Mandalli site. We review each of these sites below in rough chronological order (see also, KD Bae, 2002a,b, 2010; Norton et al., 2007a; Seong, 2007, 2009). Because chronologies change fairly frequently, we describe these sites in chronological order based on the generally accepted dates at the time of this writing.

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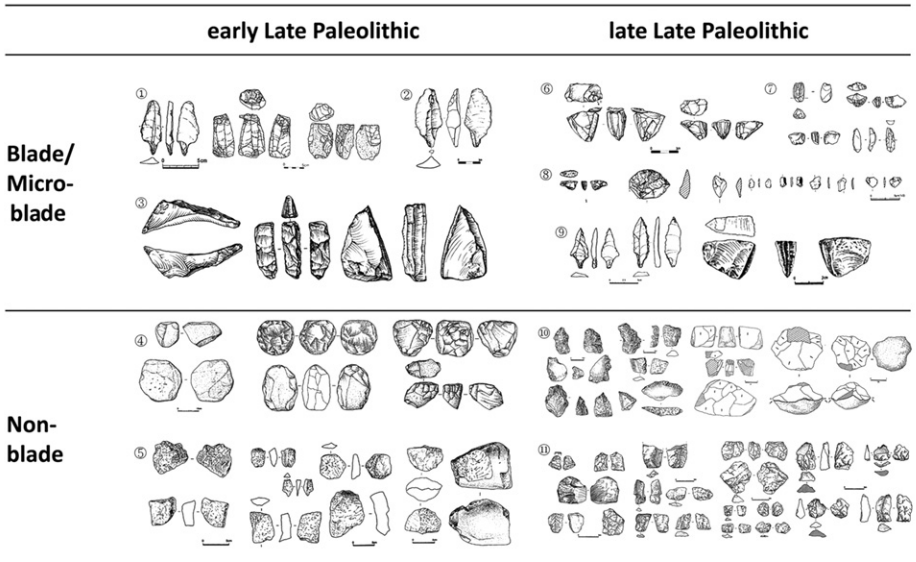

Fig. 2. Examples of lithics from the early and late Late Paleolithic. (Modified from KD Bae, 2010: his Fig. 3). (1) Goryeri; (2) Hopyeongdong layer 1; (3) Sokchangni; (4) Dangga; (5) Yullyang-ong; (6) Hopyeongdong layer 2; (7) Jangheungni; (8)Daejeongdong; (9) Suyanggae; (10) Sorori; (11) Samri.

Yonghodong is an open-air site located near Daejon in central South Korea. The site contains four cultural horizons with various core and flake tools present throughout the stratigraphic sequence (Han, 2002). At least one tanged point was found in each of the second and third stratigraphic layers. A sample of charcoal found in the third cultural level was AMS dated to 38,500 ± 1000 BP (41,926 ± 382 {cal}; Han, 2002), which would suggest that the tanged point that derives from the third layer is coeval with the charcoal. The calibrated age of the tanged point would push the boundary of the Early to Late Paleolithic transition in Korea back to more than 40,000 BP (see Norton and Jin, 2009; CJ Bae and Kim, 2010; KD Bae, 2010 for discussion and possible implications). However, others (e.g., Seong, 2009; KD Bae, 2010) have suggested it is too early to draw any conclusions regarding the Yonghodong tanged point because it is a single artifact (possibly originating from the second cultural horizon, which also has a tanged point?) and it is only one date. We agree that additional dating analyses and more research regarding the relationship between the tanged point and the charcoal are necessary to help clarify the importance of the Yonghodong findings.

Hwadaeri is an open-air site located in Kangwon Province along a tributary of the Hantan River (Choi and Ryu, 2005). Three stratigraphic levels were identified with a series of OSL analyses indicating that the first stratigraphic level dates to 22,000 ± 1000 BP, the middle horizon to 30,000 ± 1700 BP, and the lowermost stratigraphic level to 39,000 ± 1400 BP (Choi and Ryu, 2005; CJ Bae and Kim, 2010). A charcoal sample derived from the middle horizon was AMS dated to 31,200 ± 900 BP, which corroborates the OSL date. More than 5000 artifacts were found throughout the profile (Choi and Ryu, 2005; Seong, 2009). The lowermost horizon exposed artifacts comprised primarily of core and flake tools produced on locally available vein quartz and quartzite. However, the second stratigraphic level revealed the presence of a small percentage of blades and tanged points produced on porphyry, a higher quality raw material. Blades and smaller flake tools were excavated from the first horizon, but as with the second stratum, represent only a small percentage of the overall lithic assemblage (Choi and Ryu, 2005; Seong, 2009).

Hopyeongdong is an open-air site located in the central region of South Korea. Seven stratigraphic layers were identified, with cultural materials found in two separate horizons within the third stratigraphic layer (Hong and Kim, 2008). An abundance of charcoal samples were collected for AMS dating analysis. The chronometric studies indicated that the lower stratigraphic level ranged in age between 30,000 ± 1500 BP and 27,600 ± 300 BP, while the upper cultural horizon could be bracketed between 24,100 ± 200 BP and 21,1000 ± 200 BP (Hong and Kim, 2008). The artifact assemblage from the lower cultural horizon includes blades and tanged points that were produced primarily on siliceous shale and tuff. The upper cultural layer contains microblades and microblade cores produced on obsidian. In a different area of the site, microblades and microblade cores produced on siliceous shale were found with AMS dates ranging between 17,400 ± 400 BP and 16,190 ± 50 BP (Hong and Kim, 2008; Seong, 2009; KD Bae, 2010). The Hopyeongdong blades appear to be penecontemporaneous with or slightly younger than the Hwadaeri materials. As with the Hwadaeri materials, blades and microblades represent only a relatively small proportion of the overall lithic assemblage.

Dosan is an open-air site located outside of Kwangju in the southwestern part of the Korean peninsula. Four Paleolithic horizons were identified during excavations with more than 5000 artifacts recovered (Lee, 2002, in press; Lee and Kim, 2009). A series of OSL dates were analyzed on samples collected from the various strata. The age range is 61,380 ± 3000 BP from layer 1 to 28,100 ± 1950 BP from layer 4. One of the interesting aspects of the Dosan site is the presence of the typical eastern Asian Early Paleolithic core and flake stone tool industry in the older stratigraphic levels and the introduction of blades in the youngest stratum (layer 4). Most of the artifacts from Dosan are produced on locally available quartz and quartzite, but better quality rhyolite appears in layer 4, not surprisingly, coinciding with the introduction of blades (Lee, in press).

A number of sites in Korea have been dated to around the beginning of MIS 2. Some of the best described are the open-air sites of Yongsandong, Goryeri, and Janghungni (Seong, 2009; KD Bae, 2010). All of these sites' lithic assemblages are represented by increasing frequencies in blade and/or the introduction of microblades. Yongsandong is an open-air site located in Daejon. More than 2300 lithic artifacts were excavated from the brownish clay with soil cracks, including 233 blades and 37 tanged points. A soil sample taken from the brownish clay layer resulted in an AMS date of 24,430 ± 870 BP (JRICH, 2007). In Korea, the presence of soil cracks in the stratigraphy is usually interpreted to represent

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deposits laid down during the Last Glacial Maximum (Kim and Lee, 2006). Excavations at the open-air site of Goryeri in Miryang in southeastern Korea revealed the presence of a diversity of blades. Although AT tephra was identified in the overlying horizon, no chronometric dates exist for the Goryeri blades (KD Bae, 2010). Fairly clear evidence of the relationship between the advent of microblade technologies in Korea and the onset of MIS 2 is the microblade assemblage excavated from Janghungni, an open-air site from Cheolwon, in Kangwon Province. The microblade collection was excavated from the second stratigraphic level with two associated AMS dates of 24,200 ± 600 BP and 24,400 ± 600 BP (Choi et al., 2001). It should be noted that calibrating these dates will actually push them back to the terminal stage of MIS 3 (~27,000 cal. BC), which would be a very early date for the initial appearance of microliths in eastern Asia. Microblades from the Sinbuk site in southwestern Korea also have older dates (25,420 ± 190 BP; 25,500 ± 1000 BP) (Lee, 2004; Lee and Kim, 2008), that if calibrated would also predate the beginning of MIS 2 by several thousand years.

3. Hominin fossil record

The Korean hominin fossil record is relatively sparse for this time period (Park, 1992; Norton, 2000; CJ Bae, 2010). In part, this is due to the highly acidic soil in Korea that hinders bone preservation and fossilization at almost all open-air sites other than shell middens. It is also due to the lack of systematic surveys of the hundreds of caves present in the limestone mountainous regions that make up much of the peninsula (CJ Bae and KD Bae, n.d.). Two cave sites in North Korea (Ryonggok, Mandalli) and one cave locality in South Korea (Heungsu Turubong) do exist and have been relatively well researched (Fig. 2; Table 1).

Ryonggok is arguably the most important hominin bearing site on the Korean Peninsula (Norton, 2000; CJ Bae, 2010). It is located just outside the North Korean capital city of Pyeongyang (Jun et al., 1986; CJ Bae, 2010). A diversity of hominin fossils representing at least five individuals were excavated from four separate stratigraphic layers. The fossils were originally assigned to archaic *H. sapiens*, based primarily on an initial thermoluminescence date of 500,000–400,000 BP. However, later uranium-series dates placed the material around 48,000–46,000 BP and more detailed study of the morphology of the crania, including cranial capacities of 1450 cm^3 and 1650 cm^3 and the presence of a mental eminence on the associated mandibles suggest an early modern *H. sapiens* designation might be more appropriate (CJ Bae, 2010). Because the mandibles clearly represent older individuals, it was recently suggested that the site may have served as a burial site (CJ Bae, 2010). Geometric morphometric analyses would help to clarify the taxonomic assignment of the Ryonggok hominin fossils and more detailed evaluation of the site and associated archaeology could clarify the possibility of the site having served as a burial locality.

Mandalli is a cave site located along the Taedong River 20 km east of Pyeongyang (Kim et al., 1985; Norton, 2000; CJ Bae, 2010). KD Bae (2010) cites an age of 20,000 BP, while based on the biostratigraphy (e.g., *Cervus nippon*, *Vulpes vulpes*, *Hyaena* sp.) and associated archaeology the site has been dated to around the Late Pleistocene–Holocene (Norton, 2000; Norton et al., 2007a). Three stratigraphic levels were identified, with Neolithic artifacts (e.g., Chulmun pottery sherds, worked bone tools), found in the uppermost layer. Human fossils were found in the second horizon along with a small sample of obsidian tools (microcore blades and bladelets). The third stratigraphic level revealed only vertebrate paleontological materials (Norton et al., 2007a). The human fossil assemblage includes a partial cranium, two partial mandibles, and a partial humerus representing at least two modern humans (Kim et al., 1985; Park, 1992; Norton, 2000). It should be noted that published mesial–distal and buccal–lingual measurements of two lower second molars associated with the human fossils falls within the range of older archaic hominins (CJ Bae, 2010). As with the Ryonggok materials, little more can be currently said about Mandalli because of the irregular access to information about the paleoanthropology of North Korea (Norton, 2000). However, Mandalli is one of the most important sites in Korea because relatively few sites have exposed the full range of materials (e.g., hominin fossils, vertebrate paleontology, and stone artifacts) necessary to addressing paleoanthropological debates (Norton, 2000; CJ Bae, 2010).

Heungsu Cave is one of several caves that make up the Turubong cave complex (Park and Lee, 1990; Park, 1992; Norton, 2000). The site is important due to the discovery of a modern *H. sapiens* child skeleton that is thought to have been interred. Heungsu child, as it is commonly referred to as, is a fairly intact skeleton with an almost complete cranium and most of the postcrania present. Based on tooth eruption the child is thought to have been about 5–6 years old at the time of death (Park and Lee, 1990; Park, 1992). The age of the interment is thought to have been about 40,000 BP, based on the initial biostratigraphy studies. However, the relationship between the human skeleton and the associated faunas has been questioned, with the possibility that the Heungsu child is a more recent intrusive burial (Norton, 2000). Indeed, AMS dates on associated charcoal samples indicated a much more recent age (12,100 ± 130 BP; 10,390 ± 80 BP), though it should be noted that the relationship between the charcoal samples and the human skeleton is unclear.

4. Discussion

Various models have been suggested to explain the transition from the Early to Late Paleolithic in Korea. For instance, it is possible that the behavioral transition was an *in situ* evolutionary event (e.g., Seong, 2006). It is also possible that the transition represents migrations into the peninsula from blade/microblade carrying foraging groups from the north and core/flake carrying foraging groups from the south (e.g., KD Bae, 2010). Yet, a third possibility is that blade/microblade using foraging groups in the north interacted with the indigenous hominins already present in the Korean peninsula area between MIS 3–2 and the slow but increasing frequency of blades and microblades in stone toolkits, particularly after ~25,000 BP, reflect this. We evaluate each of these models in turn.

4.1. *In situ evolution model*

Seong (2009) argues that the best documentation for the Early to Late Paleolithic transition in Korea is from the evidence of larger core and flake tools, which are found in older deposits, and blade and microblades, which are found either in overlying stratigraphic layers or in younger deposits at other sites. According to Seong (2006), the increasing frequency of blades in these sites is evidence for an *in situ* evolutionary development. However, one of us has argued elsewhere that if a true *in situ* evolutionary behavioral transition occurs, then we should anticipate seeing a transition from Mode I (Oldowan) to Mode II (Acheulean) to Mode III (Levallois) to Mode IV (Blades) to Mode V (Microblades) lithic technologies (Lycett and Bae, 2010; Lycett and Norton, 2010). Currently the only region of the Old World where we see such a continuous evolutionary development is Africa (Lycett and Bae, 2010; Lycett and Norton, 2010). Indeed, the clear absence of the Levallois technology in much of eastern Asia until the MIS 3–2 transition (Gao and Norton, 2002; Norton et al., 2009), should be good evidence that eastern Asia is probably not a region where we see many clear *in situ* behavioral evolutionary

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developments during the Pleistocene. The supposed "evolutionary transition" from Mode I core and flake tools directly to Mode IV and V blade and microblade industries in Korea (e.g., Hwadaeri, Dosan) should make this point fairly evident. In our view, absence of such continuous behavioral evolutionary transitions during much of the Pleistocene in eastern Asia suggests lower population densities and bottlenecks (during the earlier part of the Pleistocene) and population movements and/or interactions (during the latter part of the Pleistocene) rather than a slow continuous evolutionary development that resulted in major shifts in the lithic technologies (for discussion see also Gao and Norton, 2002; KD Bae, 2010; Lycett and Bae, 2010; Lycett and Norton, 2010).

On a related note regarding the Seong (2008, 2009) argument, is that there is something to be said about making arguments about hominin subsistence patterns through the presence of certain types of stone tools. Indeed, Shea (2007: 226) recently justifiably observed that "recognizing the role that variability may have played in Early Paleolithic stone-tool design is a significant step toward more realistic models of early hominin subsistence". Nevertheless, we find Seong's (2009) recent attempt at correlating changes in human subsistence strategies with changes in lithic technology in Late Pleistocene Korea somewhat lacking in empirical support. Seong (2008: 881) draws two primary conclusions from his review of the Korean Late Paleolithic record: 1) presence of a tanged point "suggests hunting activities were widely practiced during the early Late Palaeolithic;" and 2) later a heavier reliance on microliths, that were supposedly used to hunt small animals and birds. Nevertheless, as Shea (2006: 842) notes, "evidence for effective big game hunting long precedes the widespread use of projectile weaponry." There is a diversity of studies from the geosciences and archaeology that support the argument that late Middle and early Late Pleistocene Neanderthal and archaic *H. sapiens* foraging groups were already proficient hunters, well before the advent of projectile technology (e.g., Marean and Kim, 1998; Richards et al., 2000; Norton and Gao, 2008a; contra Seong, 2008). There is a plethora of taphonomic literature readily available that strongly suggests that detailed evaluation of associated vertebrate paleontological remains can be much more informative than studying associated lithics to reconstruct hominin hunting prowess (or lack thereof) (e.g., Binford, 1981, 1984; Blumenschine and Marean, 1993; Blumenschine, 1995; Blumenschine and Pobiner, 2006). Indeed, there is a growing body of taphonomic studies from East Asia that provide ample evidence for early hominin hunting strategies during the Early Paleolithic or into the Late Paleolithic (e.g., Norton and Gao, 2008a,b; Norton et al., 2010a). Other recent taphonomic studies from the region have actually raised questions about archaeologists' interpretations of purported hominin kill sites (e.g., Norton et al., 2007b). Thus, vertebrate taphonomic studies should receive priority when trying to determine how effective early hominin hunting strategies may have been or when we begin to see a shift from less effective to more effective procurement patterns.

4.2. North-South [Migration] Model

One of us (KD Bae) recently proposed a new model to challenge the idea that the Early to Late Paleolithic transition in Korea occurred as an *in situ* evolutionary event. This model is referred to as the "North-South [Migration] Model" (KD Bae, 2010). The basic premise that underlies the North-South Migration Model is that Paleolithic foragers continued to be mobile up until the very end of the Terminal Pleistocene and that the introduction of blade technology is probably a result of these foraging groups from the north (e.g., Siberia) moving southward into the Korean Peninsula. In turn, using results derived from genetics studies, it was argued that foraging groups from southern China that still used Early Paleolithic core and flake tools also migrated northward to the Korean Peninsula (KD Bae, 2010). According to KD Bae (2010), these migrations, occurring from the north and south, best explains why during the Korean Late Paleolithic we see core and flake assemblages alongside blade and microblade collections. There are two points here that somewhat complicate this model: 1) genetics studies; and 2) paleobathymetric variation.

Substantial debate exists among geneticists over the nature of modern human migration patterns in eastern Asia (as reviewed recently by Stoneking and Delfin, 2010; Di and Sanchez-Mazas, 2011, and noted by Norton and Jin, 2009). Briefly, based on analyses of Y-chromosome haplotypes, two "Asian-specific" Y-chromosome haplogroups (O3-M122, D-M174), mtDNA and autosomal SNPs, some genetics laboratories concluded that not only did modern humans initially arrive in southern China, but there was at least one major migration northward around 30,000–25,000 BP and possibly a second one around 60,000 BP (Su et al., 1999; Yao et al., 2002; Shi et al., 2005, 2008; Abdulla et al., 2009). However, other genetics studies found a more heterozygous genetic profile among the northeast Asian samples than originally proposed, thus leading to suggestions that modern human migrations into eastern Asia could have reached the north first or moved initially in two directions skirting the Himalayan–Tibetan mountain range (Karafet et al., 2001; Xue et al., 2006; Zhong et al., 2010). Di and Sanchez-Mazas (2011: 81) recently concluded that "the disagreement between these different studies is mostly due to discrepant results on the amount of genetic diversity in NEAs [Northeast Asians] and SEAs [Southeast Asians]."

The primary point that can be drawn from these genetics studies related to this paper is that it is not at all clear whether modern humans reached southern China first and then migrated northward during glacial periods (MIS 4 and 2) reaching the Korean Peninsula in time to contribute to the development of the Late Paleolithic in that region. Related to this, a logical question that might be asked is why would modern human foraging groups move northward during glacial periods to face colder environmental conditions? If anything, during glacial periods there would have been a mass migration of floras and faunas southward in the face of southward expanding ice sheets rather than the reverse pattern (Norton et al., 2010b). This leads us to our second point.

Paleobathymetric studies around the Korean peninsula have indicated that during major glacial periods (e.g., MIS 6 and MIS 2) sea levels dropped anywhere from 60 m to as much as 120 m (Park, 1994, 2001; Minoura et al., 1997; Kim et al., 1999; Lee, 2007). In an earlier study that evaluated the effect of paleobathymetric variation on human foraging strategies, Norton (2007) showed that during glacial periods (e.g., Last Glacial Maximum) much of the West Sea/Yellow Sea area separating eastern China and the Korean peninsula would have been dry and at times, a land connection would have existed between southern Korea and the Japanese archipelago. Indeed, much of the West Sea/Yellow Sea sits only about 50 m, with the rest sitting no more than 100 m, below current sea levels (Fig. 3). This would have facilitated movements of floras and faunas throughout the region. With the warming period that came with the advent of MIS 1, sea levels rose to the point where some degree of territorial circumscription for mobile foragers in the region would have occurred. Although Norton (2007) was discussing archaeological implications of hominin mobility strategies in the face of paleobathymetric variation during the Terminal Pleistocene – Middle Holocene, we suggest that these factors were equally relevant to hominin behavioral decision making and mobility strategies during MIS 3–2.

Evaluation of NGRIP data graphed for the last 130,000 years indicates that MIS 3 was a relatively warm stage, not as warm as MIS 1, but clearly warmer than MIS 4 and MIS 2 (Fig. 4). Although sea levels around the Korean Peninsula during MIS 3 were probably

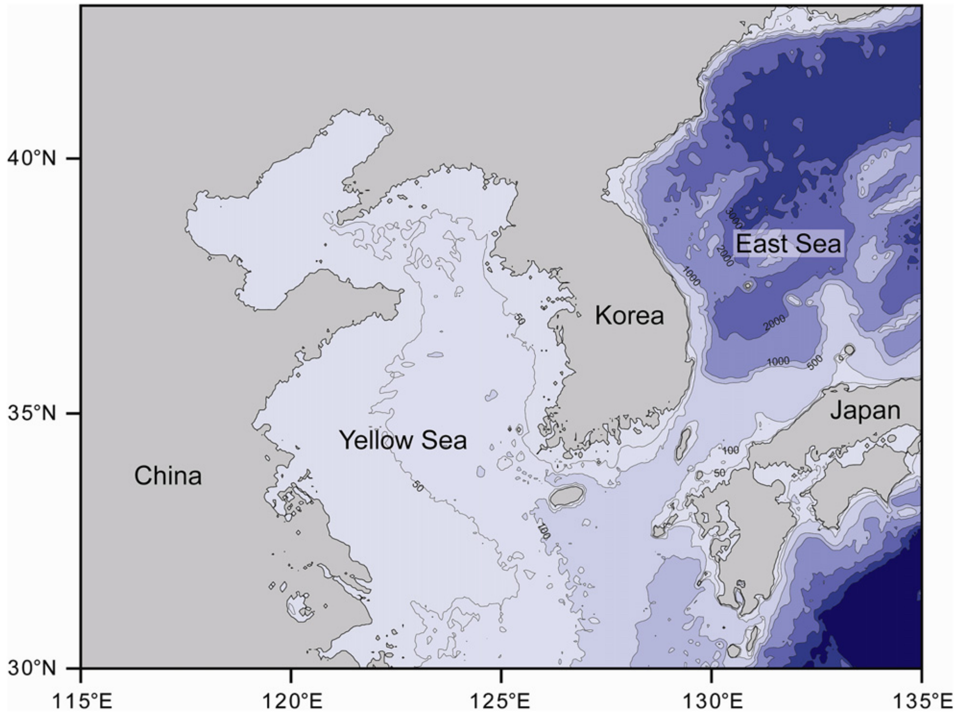

Fig. 3. Map of the West Sea/Yellow Sea region with the estimated depths. During glacial periods a 50 m drop in sea levels would have resulted in about one half of the area as dry land. During more significant glacial periods, with more significant drops in sea levels, all of the West Sea/Yellow Sea region would have been dry land.

not as high as today, they were clearly higher than during the glacial periods. This suggests that during warm stages, the West Sea/Yellow Sea would have been lower during MIS 3, but not completely dry as what probably occurred during MIS 6 and MIS 2. In turn, this would have hindered hominin mobility strategies, particularly any that resulted in migrations northward by hominins living in southern China during MIS 3. During MIS 2, much or all of the West Sea/Yellow Sea would have been dry, which would have

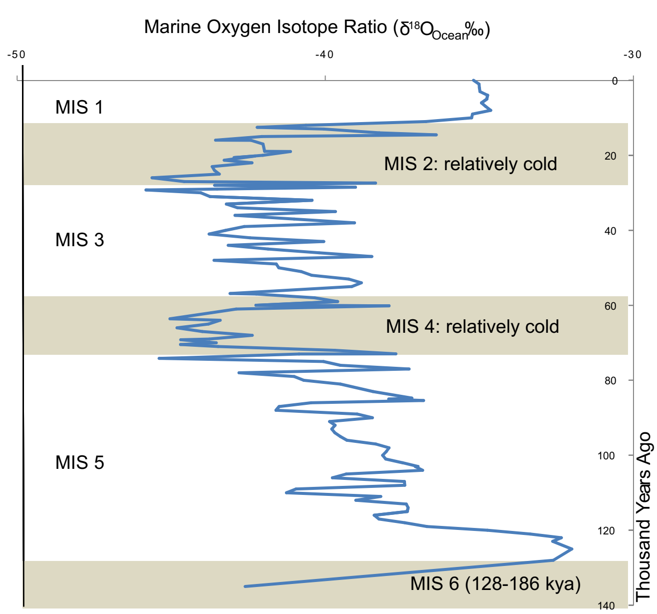

Fig. 4. Reconstruction of the variability in marine isotope stages 1–6. Marine isotope stage data drawn from the North Greenland Ice Core Project (http://www.gfy.ku.dk/www-glac/ngrip/index_eng.htm).

facilitated movement through the region. However, as we pointed out above, why would hominin foraging groups be inclined to move northward in the face of an increasing hostile environment, particularly when many floras and faunas would have been migrating southward?

4.3. Migration/trade interaction model

This model should be viewed as a modified version of KD Bae's (2010) "North-South [Migration] Model". There are two primary differences. First, human migrations into the Korean peninsula from southern China have yet to be convincingly documented. This is despite the fact that some genetics studies suggest modern humans arrived initially in southern China and moved northward. Any northward (or southward) migration in eastern Asia documented through genetics research need to account for factors such as varying paleobathymetry if including regions such as coastal areas and islands. In particular, in light of variability in paleobathymetry during the MIS 3–2 transition it should be fairly evident that at times hominins around the east coast of China and the Korean peninsula would have faced varying degrees of territorial circumscription. This would have included restricted direct access to the Korean peninsula from southern China during parts or most of MIS 3.

Second, if there were clear large scale migrations (resulting in presumed replacements) southward into the Korean peninsula from regions like Siberia by blade and microblade carrying human foraging groups then we might anticipate seeing breaks in the archaeological record. For instance, we might expect to see situations where Mode IV (Blades) and Mode V (Microblades) dominated stone tool technologies suddenly appear in horizons immediately overlying Mode I (Oldowan) stone toolkits. These types of cases might be interpreted as a new group of humans moving into the region. However, in Korea it is fairly well documented that between ~40,000–30,000 BP blades and tanged points begin to appear in small frequencies in strata that are still dominated by traditional Early Paleolithic core and flake stone toolkits (e.g., Yonghodong, Hwadaeri, Hopyeongdong), including sometimes bifacially worked implements (Seong, 2009; KD Bae, 2010). The archaeological record currently suggests that it is not until after the advent of MIS 2 that blade and microblade stone tool industries become more dominant in the Korean peninsula.

The slow introduction of blade and tanged points, rather than a quick replacement of those tool types over the Early Paleolithic stone tool industries, might actually be suggestive of some type of slow introduction of human foragers' influence into the region either through direct occasional migrations or some type of trade interactions (Norton and Jin, 2009). Although it is difficult to document trade interactions during MIS 3, obsidian from sites dating to ~30,000 BP situated on the Kanto Plain in Honshu, Japan has been sourced to Kozushima (Ikawa-Smith, 2008). Kozushima is an offshore island that would have been minimally separated from Honshu by at least 40 km of open water during glacial periods. During MIS 2, there is evidence that obsidian was moved upwards of 300 km from Hokkaido to Sakhalin as early as 23,000 BP (Kuzmin et al., 2002). *Arca* shells appear in the Zhoukoudian Upper Cave assemblage that probably originated from the West Sea/Yellow Sea, indicating movement of at least 150 km to possibly as far away as 500–600 km depending on which date one uses for the cultural layers and where the paleocoastline would lie (Norton and Gao, 2008b; Norton and Jin, 2009). Although movement of obsidian and *Arca* shells could represent long distance migrations by mobile human foraging groups, it is possible that they also represent trade interactions (Norton and Jin, 2009).

5. Conclusion

One point that should be clear from this synthesis is that if modern humans swept into eastern Asia carrying with them a superior stone tool industry and replacing the indigenous peoples, they do not appear to have done much sweeping in the Korean peninsula. Indeed, we see only a few blades and tanged points in the early Late Paleolithic sites, lithic assemblages that are still dominated by the core and flake tools that represent the eastern Asian Early Paleolithic. It is only after ~30,000 BP that blades, tanged points, and microblades begin to represent a larger proportion of the overall stone tool industries. Thus, a sudden overall replacement of Early Paleolithic core and flake tool industries by blade and microblade stone toolkits is not evident in Korea. This archaeological pattern could be interpreted as evidence of a slow *in situ* evolutionary behavioral development (Seong, 2006, 2009). However, a more parsimonious explanation is that the slow transition from core and flake tools to a heavier reliance on blades, tanged points, and eventually microblades by the end of MIS 3 is that human foraging groups physically moved down from the north (e.g., Siberia, Mongolia) in small scale migrations or these more northerly groups may have traded with indigenous peoples living in Korea during MIS 3–2 (see also KD Bae, 2010). Although it may be possible that there were large scale migrations from southern China, as we noted above, different genetics laboratories have come to very different conclusions regarding these supposed mass migrations. Including discussion of the variability of the paleobathymetry of the West Sea/Yellow Sea region during glacial and non-glacial periods further complicates arguments of mass migrations from the south into the Korean peninsula.

It is unfortunate that we cannot access the North Korean hominin fossils that date to MIS 3–2. It would be useful to conduct a detailed morphometric study of the hominin fossils from Ryonggok and Mandalli (and possibly Heungsu Child if it does indeed date to the Late Pleistocene rather than the Terminal Pleistocene or Holocene). However, a recent analysis of the Tianyuandong human fossil that dates to ~40,000 BP found some interesting similarities with western European early modern humans (Shang et al., 2007). This might support the argument of some modern human foraging groups that originated in the western Old World moving into the region after 40,000 BP and bringing with them blade technologies (Norton and Jin, 2009).

Because of large scale paleoanthropological field initiatives currently being conducted in South Korea, it should only be a matter of time before good sites with adequate Pleistocene hominin and other vertebrate fossils and Paleolithic archaeology are identified (CJ Bae and KD Bae, n.d.). These new sites should help clarify the nature of the Early to Late Paleolithic transition in Korea and from a broader regional perspective, eastern Asia.

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