

# *Toward an Understanding of Technological Variability in Microblade Assemblages in Hokkaido, Japan*



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ANATOMICALLY MODERN HUMANS colonized much of the previously uninhabited world in the late Last Glacial Maximum (LGM). A particularly fascinating issue concerns colonization processes of the former periglacial regions, which have been intensively discussed in studies devoted to Europe and northern Asia (papers in Eriksen and Straus 1998; Gamble 1986; Straus 1991; Straus et al. 1996; Velich'ko and Kurenkova 1990).

In northern North America and northeastern Asia, including Hokkaido, microblade technology was employed by modern humans from the LGM to the initial Holocene as a key element of their adaptations (Chen 1984; Derev'anko 1998; Goebel and Sloboldin 1999; Hamilton and Goebel 1999; Hoffecker et al. 1993; Seong 1998; Shimpei Katou 1984). Detailed lithic technological analyses in Hokkaido have revealed the existence of various microblade reduction methods.<sup>1</sup> Many scholars (Katou 1984; Tsurumaru 1979) suggest that technological studies in Hokkaido are of crucial importance to understanding the origin and dispersal of microblade assemblages in northern North America and northeastern Asia. Few overviews on this subject, however, are available in English (but see Hayashi 1968; Kobayashi 1970; Morlan 1967).

In this paper, we survey recent research on microblade assemblages during oxygen isotope stage 2 (OIS-2) in Hokkaido and provide a geoarchaeological explanation for technological variability in microblade assemblages on this large island of northern Japan.

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GEOLOGY, GEOARCHAEOLOGY, AND PALEOENVIRONMENT IN HOKKAIDO  
DURING OIS-2

Since we argue that technological variability in microblade assemblages was conditioned by unique regional geology and environmental circumstances, it is necessary to describe the geology, geoarchaeology, and paleoenvironment in Hokkaido during OIS-2.

Microblade assemblages in Hokkaido have been discovered at more than 300 sites. They occur at several clusters of sites, each correlating to a specific landform division (Figure 1*a*). For instance, more than 200 sites have been found in the site cluster of the Tokoro River system, to which this paper pays particular attention (Figure 2). Results of the general surveys of Tokoro show that many sites are located along the margins of terraces and hills. However, consideration of topographical formation mechanisms, such as periglacial processes, indicates a sampling bias in the existing site distribution. It is presumed that sites with various functions were once located on mountains, buried terraces, and buried natural levees, areas in which general surveys have rarely been conducted. In the following, a geoarchaeological overview is attempted together with discussion of results of geoscience studies in order to give a general background for understanding the technological variability in microblade assemblages.

Hokkaido is a portion of the arc-trench system that is situated along the west margin of the Pacific Ocean, and is located at the junction of the northeast Japan and Kurile arcs. Sakhalin extends northward from Hokkaido, the Kurile Islands eastward, and Honshu southward (Figure 1*b*). Hokkaido was formed chiefly by two events: plate subduction and seamount accretion from the Jurassic to Cretaceous periods (G. Kimura 1985), and subduction of the Pacific plates and collision of the Kurile Arc after the Tertiary (G. Kimura 1981).

This main geomorphological features—mountains and plains—of Hokkaido were formed under tectonic conditions (Figure 1*a*). The Hidaka Mountains, situated in the southern part of the central axis of Hokkaido, mainly consist of pre-Tertiary sedimentary rocks and metamorphic rocks. The thrust of these mountains was caused by the collision of the Kurile Arc since the beginning of Tertiary. The Kitami Mountains, situated in the northern part of Central Hokkaido, consist of mainly pre-Tertiary green rocks and sedimentary rocks, and Tertiary volcanic rocks and sedimentary rocks. They represented a Tertiary volcanic front and thrust zone. The Ishikari Mountains and Shiretoko Volcanic Zone consist of Quaternary volcanic rocks and tephra. They have been active volcanic fronts throughout the Quaternary. Hills, plains, and basins in Hokkaido were formed by the same tectonics as those mentioned above, and consist mainly of Tertiary sedimentary rocks, Quaternary terrace deposits, and tephra.

Human lithic raw material procurement strategies were conditioned by such geological structures. For instance, the morphological features of rocks distributed in the neighborhood of outcrops show debris and angular gravel patterns. Debris and angular gravel change to rounded gravel in a continuous way because of weathering and transportation processes. Geomorphological and physical aspects, including fracture mechanics, strongly conditioned lithic morphology. Artifact interassemblage variability in Hokkaido was conditioned by the distribution of lithic raw material that consisted of a variety of rock types, morphological fea-

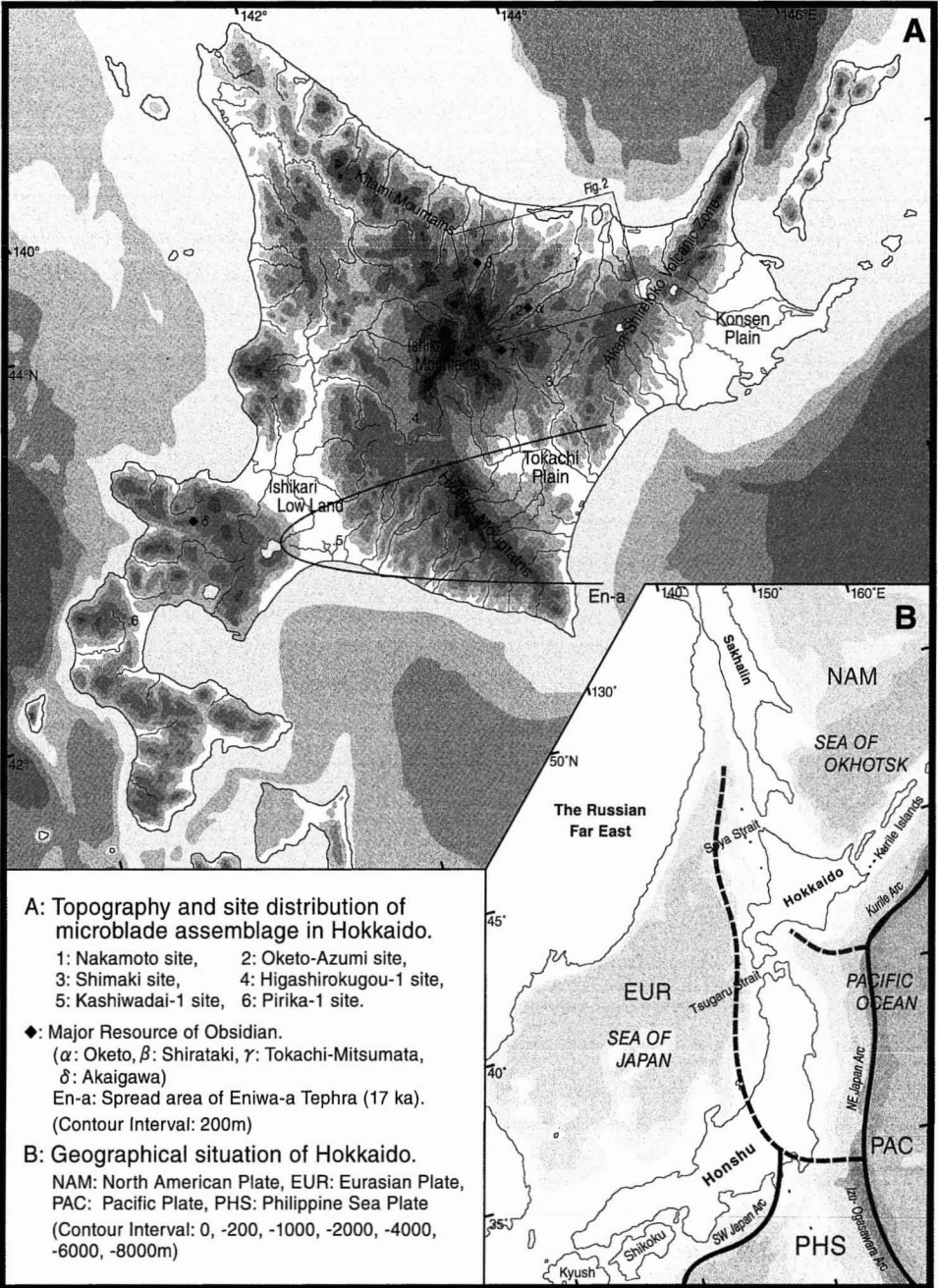


Fig. 1. Geographical setting in and around Hokkaido. *a*: Topography and site distribution of the microblade assemblages in Hokkaido; *b*: Geographical situation of Hokkaido.

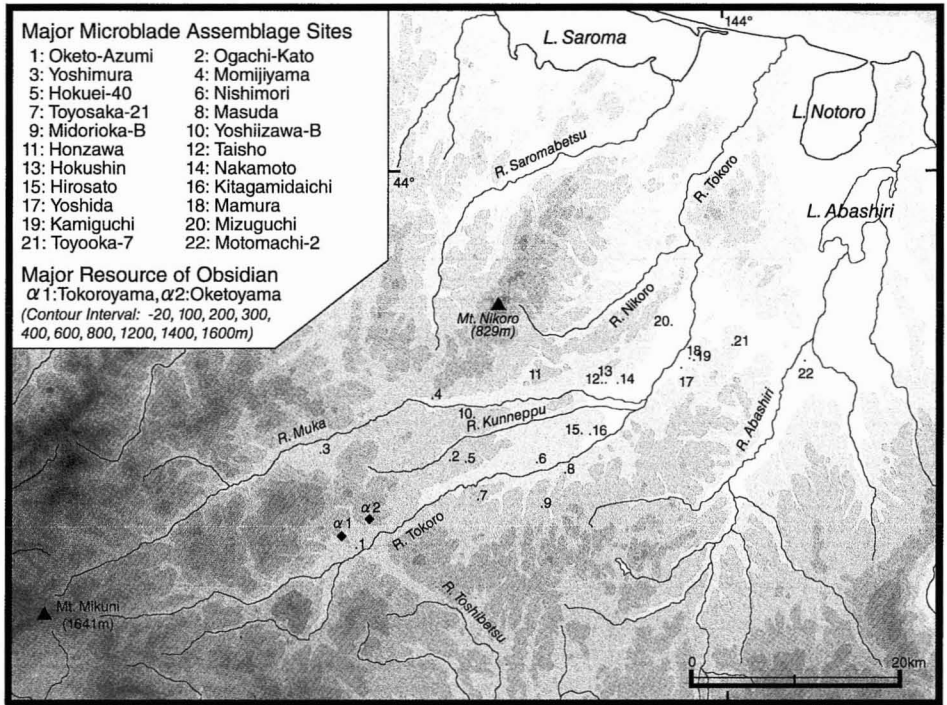


Fig. 2. Topography and site distribution of microblade assemblages in and around the Tokoro River system.

tures, and lithofacies. This relationship should be fundamental to understanding the interassemblage variability in Hokkaido.

In recent years, earth scientists have claimed that reconstruction of the paleo-environment needs to be understood within the framework of teleconnection of the Earth system. This claim is the fundamental and necessary condition in order to consider the landscape in Hokkaido during OIS-2 (ca. 24,000–12,000 B.P.). Abrupt climatic changes in millennial cycles during the LGM indicated by  $\delta^{18}\text{O}$  analysis of Dansgaard-Oeschger cycles recorded in Greenlandic ice core can be tracked in many areas of the northern hemisphere. Many aspects influenced by Dansgaard-Oeschger cycles can be confirmed in Hokkaido as well (Shiga and Koizumi 2000).

The inherent landscape of Hokkaido, however, was generated by its geographical conditions such as the periglacial environment on an island arc situated on the eastern margin of the Asian continent. Sea level dropped an estimated 105–130 m in the LGM. Applying this value directly to the ancient shoreline of Hokkaido during the LGM, it is estimated to have been about 10 km out from the present shoreline. A land bridge must have existed in the Soya Strait, because its present sill depth is only about 60 m; subsequently, Hokkaido was connected with Sakhalin during the LGM (Ono 1990). On the other hand, a land bridge did not emerge in the Tsugaru Strait, because its present sill depth is about 130 m; there-

fore Hokkaido likely was not connected with Honshu throughout the LGM. Although the argument concerning a dry land connection across the Tsugaru Strait during the LGM is as yet inconclusive (Ono 1990), it is at least presumable that the width of this strait was reduced to less than 2 km.

The sea ice that covered the northern part of the Sea of Japan and coastal area of the Sea of Okhotsk during the LGM is assumed to have had a different distribution from that of the present. Diatom analysis shows that the western part of the Sea of Okhotsk, including the northeastern coastal area of Hokkaido, was covered with perennial sea ice (Shiga and Koizumi 2000). The northern part of the Sea of Japan was also covered with perennial sea ice, because the much shallower Tsushima Strait blocked the northward penetration of the Tsushima current and sea surface temperature was remarkably decreased (Matsui et al. 1998).

This ocean environment affected natural environments of the land area including the formation of topographical features. Precipitation in Hokkaido during OIS-2 decreased compared to OIS-3 and OIS-4, because the winter monsoon from the Asian continent was not humidified by moisture over the Sea of Japan. Therefore, dust deposition from the Asian continent increased in OIS-2 under the cold and dry climate (Ono and Naruse 1997). Analysis of fossil periglacial phenomena suggests that northeastern Hokkaido was located at the southernmost margin of the continuous permafrost zone during the LGM (Miura and Hirakawa 1995). A large amount of tephra was produced from volcanoes in Hokkaido during the late Pleistocene (Okumura 1991). In particular, the En-a tephra erupted approximately 17,000 B.P. (Shigehiro Katou 1994); this is correlated chronologically with microblade assemblages in the southern part of the Ishikari Lowland and the Tokachi Plain (Satou 2003).

Flora and fauna were deeply influenced by the cold, dry climate of the LGM. Taiga, which consisted mainly of *Larix*, existed in central and southern Hokkaido, and a landscape that consisted of patches of grassland, coniferous forest, marshes, and alpine tundra grew in northern and eastern Hokkaido (Ono 1990). Data on faunal remains in Hokkaido are very scarce. Although large mammal fossils of the middle and late Pleistocene, such as *Palaeoloxodon naumanni*, *Mammuthus primigenius*, *Sinomegaceros*, and *Bison*, are known in Hokkaido, most of them are not from archaeological sites. It is considered that the boreal fauna had dispersed from the northern Asian mainland to Hokkaido during OIS-2, but mammal fossils that certainly belong to OIS-2 are only those of *Bison* (Akamatsu et al. 1999).

The reconstructed landscape of Hokkaido during OIS-2 indicates that it had many common features with Sakhalin and the Russian Far East, but some indigenous features as well. It is certain that some data from archaeological sites have been distorted through soil forming processes. For instance, organic materials, such as bone and wood, decayed under the highly humid conditions and acid soils. As a result, lithic specimens are the almost exclusive materials for Paleolithic studies in Hokkaido.

#### TECHNOLOGICAL VARIABILITY IN MICROBLADE ASSEMBLAGES AND THE CHRONOLOGICAL FRAMEWORK

Studies of microblade assemblages in Hokkaido have been directed mainly toward analysis of the attributes of microblade cores and refitting of lithic remains (H.

Kimura 1992; Tsurumaru 1979). With such efforts, several microblade reduction methods and microblade core types have been defined as effective type fossils. Several classification systems of the reduction methods and core types were presented by Tsurumaru (1979) and others. Despite the accumulation of new material, the framework of the classification systems themselves has not required any major alterations, demonstrating its effectiveness on this matter.

Outlines of the major microblade core types and their reduction methods so far known are shown in Figure 3 and described briefly below.

1. Sakkotsu and Shirataki type: Microblade cores applied by the Yubetsu method, which involves preparing mainly bifacial or boat-shaped core blanks with symmetrical cross sections and forming platforms by removing spalls. While microblade cores of the Sakkotsu type are relatively large and wide, microblade cores of the Shirataki type tend to be smaller and narrower, and in the case of obsidian have obvious traces of scratching on the platforms. In addition, the so-called Pirika type is a variety of the Sakkotsu type.

2. Tougeshita type: Microblade cores of the Tougeshita method, which involves preparing unifacial blanks on flakes or blades with asymmetrical cross sections and forming platforms generally by removing spalls.

3. Oshorokko type: Microblade cores of the Oshorokko method, which involves preparing relatively small bifaces as blanks and forming platforms generally by removing short spalls.

4. Rankoshi type: Microblade cores of the Rankoshi method, which involves forming platforms at the ends of elongated wedge-shaped blanks and detaching blades or microblades parallel to the long axes.

5. Hirosato type: Microblade cores of the Hirosato method, which involves forming platforms by preparing the ends of large blades and detaching microblades parallel to the long axes.

6. Horoka type: Microblade cores of the Horoka method, which involves preparing boat-shaped blanks and then detaching microblades from the sharp ends of platforms.

7. Oketo type: Conical or prismatic microblade cores, on which platforms were made early in the reduction process and then blades or microblades were detached around the platforms with elaborated preparation.

Given these formal types, it is critical to understand the meaning of the variability among these microblade reduction methods and among assemblages on the whole, in the context of the overall behavioral system, and to construct a theoretical framework for their interpretation. It is almost impossible to establish chronological relationships among these microblade core types or reduction methods; a debate is still in progress on this issue. Nevertheless, based on a change of diagnostic tool classes, it is safe to say that microblade assemblages in Hokkaido can be divided into at least two periods: early and late. While there is no abrupt change in overall lithic technology between the two periods, new classes of stone tools in the late period indicate that technological innovation may have been pronounced in the late period. For example, microblade assemblages are often accompanied by new tool types such as bifacial leaf-shaped points, bifacial stemmed points, flake adzes, and bifacial axes. These are generally not seen in the early period. This chronological framework is supported by the results of radiometric dating.

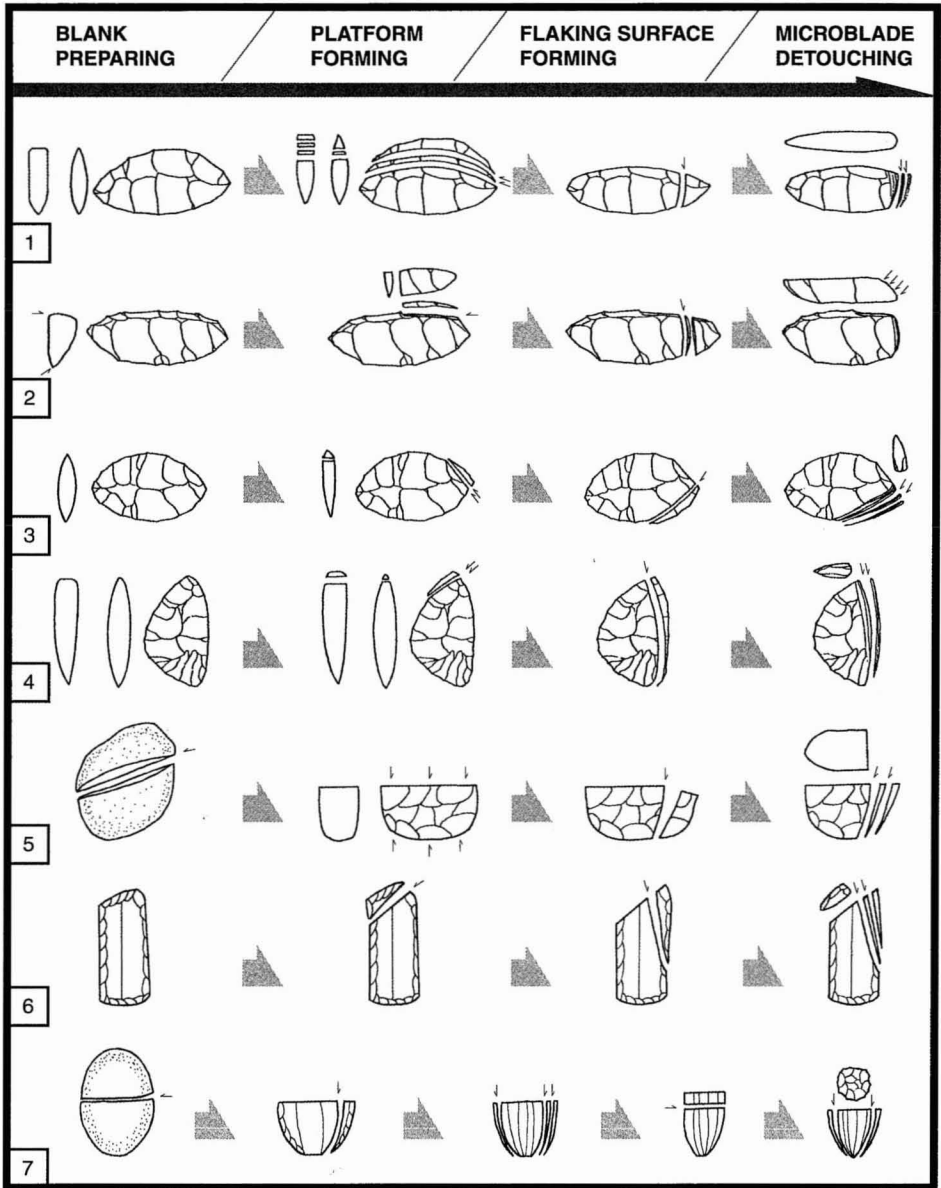


Fig. 3. Various microblade reduction methods in Hokkaido (1–4: modified from Tsurumaru 1979). 1: Yubetsu method; 2: Tougeshita method; 3: Oshorokko method; 4: Rankoshi method; 5: Horoka method; 6: Hirosato method; 7: Oketo method.

### *Early Period*

The early microblade assemblages consist mainly of the Rankoshi, Tougeshita, and Sakkotsu types. Major tools are burins, end scrapers, and side scrapers. In considering the chronological position of the early microblade assemblages, it is important to note that the date of the En-a tephra is estimated to be ca. 17,000

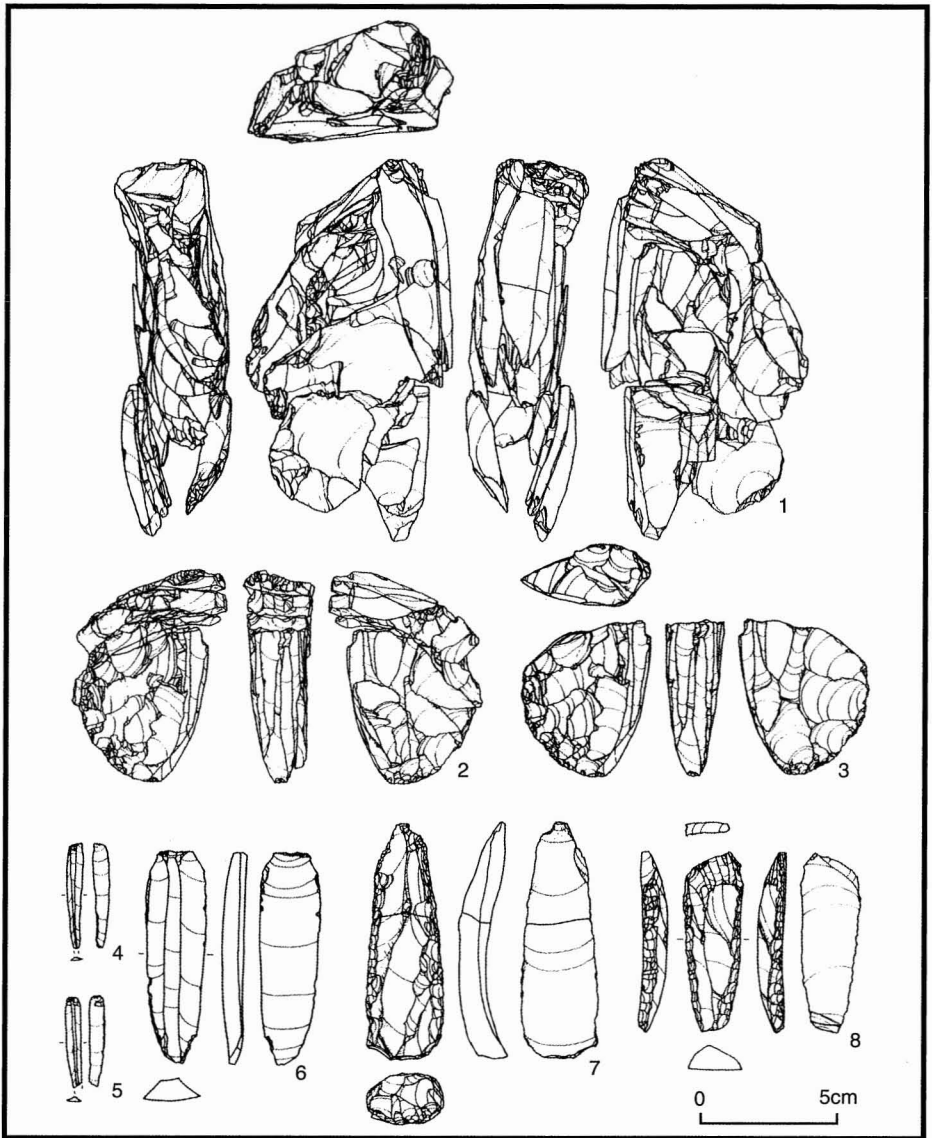


Fig. 4. Artifacts from the early microblade assemblages, Kashiwadai-1 site (Hokkaido Buried Cultural Property Centre 1999). 1, 2: reduction process before microblade core; 3: microblade core; 4, 5: microblade; 6: blade; 7: end scraper; 8: burin.

B.P. (Shigehiro Katou 1994). Recently, a microblade assemblage with the Rankoshi type of core was recovered from below the primary En-a pumice fall deposit in the Kashiwadai-1 site (Figure 4). Most of the AMS  $^{14}\text{C}$  dates obtained on charcoal from hearths (Table 1; 1–7) fall around 20,000 B.P. (Hokkaido Buried Cultural Property Centre 1999). Therefore, most assemblages with the Rankoshi type discovered to date can be dated to earlier than the En-a tephra. Assemblages similar to that of the Kashiwadai-1 site were found in the lower layer of the



TABLE 1. CONVENTIONAL RADIOCARBON AGE FROM MICROBLADE ASSEMBLAGE IN HOKKAIDO

SITE/CONTEXT	PROVENANCE	MATERIAL	LAB NO.	DETERMINATION	REFERENCE
1. Kashiwadai 1, layer 4	Concentration 6, hearth	Charcoal	Beta-126170	20,130 ± 150	Hokkaido Buried Cultural Property Centre 1999
2. Kashiwadai 1, layer 4	Concentration 12, hearth	Charcoal	Beta-126175	20,790 ± 160	Hokkaido Buried Cultural Property Centre 1999
3. Kashiwadai 1, layer 4	Concentration 12, hearth	Charcoal	Beta-126184	20,610 ± 160	Hokkaido Buried Cultural Property Centre 1999
4. Kashiwadai 1, layer 4	Concentration 14, hearth	Charcoal	Beta-120881	19,840 ± 70	Hokkaido Buried Cultural Property Centre 1999
5. Kashiwadai 1, layer 4	Concentration 14, hearth	Charcoal	Beta-120883	20,370 ± 70	Hokkaido Buried Cultural Property Centre 1999
6. Kashiwadai 1, layer 4	Concentration 15, hearth	Charcoal	Beta-126176	20,700 ± 150	Hokkaido Buried Cultural Property Centre 1999
7. Kashiwadai 1, layer 4	Concentration 15, hearth	Charcoal	Beta-126177	18,830 ± 150	Hokkaido Buried Cultural Property Centre 1999
8. Nakamoto, layer 5	Concentration 06, dense charcoal 3	Charcoal	Beta-111878	12,580 ± 90	Nakamoto Site Research Group in press
9. Nakamoto, layer 5	Concentration 04, hearth 1	Charcoal	Beta-111879	12,380 ± 90	Nakamoto Site Research Group in press
10. Nakamoto, layer 5	Concentration 02, dense charcoal 2	Charcoal	Beta-111880	12,280 ± 170	Nakamoto Site Research Group in press
11. Nakamoto, layer 5	Concentration 11, dense charcoal 5	Charcoal	Beta-126242	12,320 ± 50	Nakamoto Site Research Group in press

Pirika-1 site and others, where some Sakkotsu and Tougeshita type microblade cores were also discovered (Hokkaido Buried Cultural Property Centre 1985). Although their relationship to the Rankoshi type still remains largely unclear, this illustrates that some of the Sakkotsu type and Tougeshita type can also be attributed to this period. Importantly, the Yubetsu method of using bifacial blanks has not been found at a site earlier than the En-a tephra. Microblade-like flakes and a microblade core recovered from the Shimaki site (Shimaki Site Excavation

Group, University of Tsukuba 1988) and some others have been attributed to approximately 20,000 B.P., and some scholars have pointed out that microblade technology already existed in this period. There is a large gap, however, between the extremely refined microblade technology of the Kashiwadai-1 site and that of the Shimaki site.

Assemblages with the Sakkotsu or Tougeshita type have been recovered from the layers above the En-a tephra in Tokachi Plain and the southern part of Ishikari Lowland. Such assemblages are distributed all over Hokkaido. Although either the Sakkotsu or Tougeshita type is generally dominant in a site, these two types apparently coexisted at some sites, including Akatsuki (Obihiro City Board of Education 1986). Archaeological materials obtained from sites close to lithic quarries, such as the Shirataki-Horokazawa site locality Toma and the Oketo-Azumi site, show that the Sakkotsu type cores display varied reduction sequences depending on the morphological features of lithic raw materials (Engaru Town Board of Education and University of Tsukuba 1990; H. Kimura 1992; Shimada and Yamashina 1998).

#### *Late Period*

Microblade cores of the late microblade assemblages mainly consist of the Shirataki, Oshorokko, and Hirosato types. Retouched tools of these assemblages are dominated by various types of burins, numerous end scrapers, side scrapers, and drills, all made on blades detached from prismatic blade cores. The reduction sequence of blades is characterized by intensive core preparation, often with creation of only a single platform. In addition, the late microblade assemblages contain bifacial leaf-shaped points, bifacial stemmed points, flake adzes, and bifacial axes (including edge-ground ones). In this period, as suggested by Shimpei Katou (1970), intersite or intrasite variability of the tool kits became more remarkable, and we can recognize differences in every aspect of the tool kit composition.

Table 1 presents the results of the AMS  $^{14}\text{C}$  dating of charcoal from lithic concentrations with Hirosato type microblade cores at the Nakamoto site. These dates represent a fairly reliable chronological database for the late microblade assemblages in Hokkaido. They show that the late microblade assemblages in Hokkaido seem to have appeared during the Terminal Pleistocene.<sup>2</sup> In this period, the manufacturing of ceramics, which occurred in the Russian Far East and the Japanese islands (Honshu, Kyushu, and Shikoku), was extremely rare in Hokkaido (Derev'anko and Medvedev 1995; Imamura 1997). The ceramics excavated at the Higashirokugou-1 site (Furano City Board of Education 1987) in central Hokkaido may show the existence of ceramics during the terminal Pleistocene. Consequently, the scarcity of evidence does not permit us to answer the question of how settlement, mobility patterns, and subsistence strategies changed after the advent of pottery manufacturing.

It is notable that the morphological features of the lithic raw material—its size and surface condition—influence the technological variability of the late microblade assemblages in Hokkaido. This outstanding issue will be discussed here by considering the refitted materials obtained from the assemblages with microblade cores of the Oshorokko type and the Hirosato type. Lithic raw materials of the

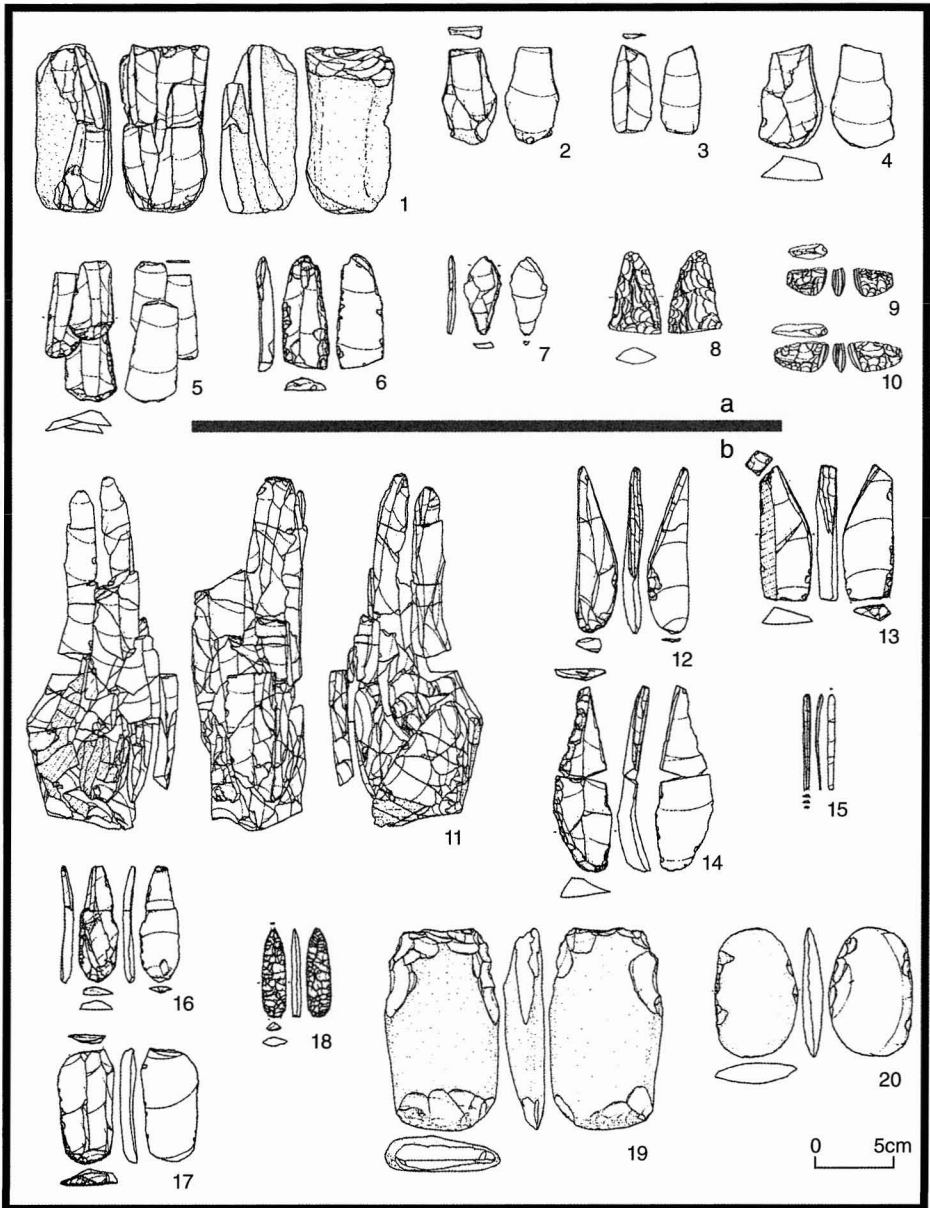


Fig. 5. Artifacts from the late microblade assemblages. *a*: Yoshiizawa-B site (Oba et al. 1983; Takakura 2000); *b*: Nakamoto site (Nakamoto Site Research Group in press). 1: blade core; 2–4: blade; 5, 17: end scraper; 6, 7, 16: burin; 8, 18: biface; 9, 10, 12–14: microblade core; 11: refitted blades; 15: microblade; 19: axe; 20: adze.

assemblages with the Oshorokko type, such as the Yoshiizawa B site (Oba et al. 1983; Takakura 2000), are dominated by round gravel. Since the length of the round gravel used as raw material is only about 10–20 cm, bifaces and numerous retouched tools made on blades in these assemblages are small (Figure 5*a*). On the

other hand, lithic raw materials of the assemblages with the Hirosato type, such as the Nakamoto site (Nakamoto Site Research Group in press), are characterized by using raw materials of debris and angular gravel. Because the length of these clasts is about 20–50 cm, bifaces and numerous retouched tools made on blades in these assemblages are larger (Figure 5*b*).

The assemblages with the Oshorokko type and those with the Hirosato type show impressive differences in microblade and blade reduction sequences. In terms of the spatial distribution of the sites, however, there is little difference between the assemblages with these microblade core types. Owing to some coexisting cases within a single site, both of these microblade cores do not seem to have different chronological positions. As pointed out in the previous section, debris and angular gravel can be procured from the outcrops and along the upper portion of the Tokoro River, and round gravel can be procured along the middle to lower points of the river. Therefore, it is plausible that the localities of lithic raw material procurement affected the ways that microblade cores and blade cores were reduced. Accordingly, knowing such a relationship between lithic reduction sequences and morphological features of lithic raw materials is important not only for understanding the background of technological variability in the late microblade assemblages, but also for drawing an inference on behavioral patterns in this period.

Finally, the issue of the Oketo type should be briefly mentioned. Few data have been reported on this core type. This makes it difficult to come to an archaeological evaluation of the Oketo type. It will require many more excavations before a proper evaluation is made.

#### DISCUSSION AND CONCLUSIONS

Many studies of microblade assemblages in Hokkaido have focused on identifying specific core types and reduction methods. As a result, it is widely known today that there was remarkable technological variability among microblade assemblages in Hokkaido. A persuasive hypothesis on the formation processes of this variability, however, has not been yet presented.

First, this paper attempted to survey natural environmental conditions during OIS-2 in order to obtain a background idea for understanding the formation processes of the technological variability. Although we are far from a complete understanding of a detailed chronology, the data so far available show that microblade assemblages in Hokkaido can be divided into at least two periods. Second, current research on microblade assemblages based on this chronological framework is discussed, considering the relationship between lithic raw materials and lithic reduction sequences. Microblade assemblages have been uncovered in most areas of Hokkaido through general surveys and a large number of excavations. This makes it possible to discuss from a geoarchaeological perspective how geological conditions constrained interassemblage variability. The relationship between the Hirosato and Oshorokko types should be well associated with a difference between large debris or angular gravel on one hand and small gravel on the other. This means that lithic reduction sequences were altered according to the morphological features of lithic raw materials that late Upper Paleolithic hunter-gathers procured.

The interpretation presented here, however, is not fully conclusive, because the assemblages for which we can discuss the lithic technological variability and its formation processes are definitely limited. It is apparent that we should specify the extent to which this prospect can be applied. Besides morphological features of procured lithic raw materials, the quality of lithic raw materials affects reduction sequences (Brantingham et al. 2000). Moreover, it is necessary to consider behavioral variables such as group mobility strategies (Kelly 1988), production risk and cost (Bamforth and Bleed 1997; Bleed 1996, 2003; Torrence 1989), and transportability of stone tools (Kuhn 1994; Nelson 1991). These variables should be plugged into future research because they may have played some roles in shaping reduction sequences of microblade cores defined as seven microblade reduction methods. Nevertheless, a notable result of our discussion is to suggest the possibility of defining an interesting pattern of technological variability, considering the relationships among morphological features of lithic raw material and lithic reduction sequences. This view makes it necessary to reexamine the meaning of splitting microblade core types and reduction methods in detail. Identifying the effects of the procured lithic raw material types is essential to explain varied types of microblade cores and reduction methods, and is absolutely necessary before determining a meaningful archaeological explanation for their patterns.

A powerful model explains the origin of microblade assemblages with wedge-shaped microblade cores. It claims that these assemblages dispersed from Transbaikal to various parts of northeastern Asia (Goebel et al. 2000; Shimpei Katou 1984). However, the excavation of the Kashiwadai-1 site confirms that wedge-shaped microblade core technology existed in Hokkaido as far back as the LGM. Surely, definite evidence that the microblade assemblages with wedge-shaped cores in Hokkaido date to the LGM is still rare, because few excavations have been carried out in order to identify the origin of microblade assemblages. Moreover, since archaeological records in Hokkaido before the LGM have generally not been recovered, unlike the abundant blade assemblages that appeared at 40,000 B.P. in Siberia (Goebel 1999), a chronological relationship between macroblade and microblade technologies has not been revealed. Thus, it is necessary to accumulate more cases of the earliest microblade assemblages with reliable dates evaluated by the examination of site formation processes from geoarchaeological perspectives. Nonetheless, the authors believe that various microblade technologies existed in Hokkaido during the LGM. Hence, technologically variable microblade assemblages may have occurred independently in other areas of northeastern Asia in the LGM as well. Understanding the technological variability among microblade assemblages in various parts of northeastern Asia will become an important issue.

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## NOTES

1. In this paper, "microblade reduction method" is defined as a sequence from preparing microblade core blanks to detaching microblades. Historically, Japanese archaeologists have used the term *Saiseikijin-gihou* (technique of microblade production) to describe a series of processes of microblade production (Hayashi 1968). However, this term ties with the assumption that each method of microblade production reflects a cultural trait, as if *fossil directeurs*, to establish a chronology (e.g., Terasaki 1999). In order to dismiss this unreliable assumption, we use the term "microblade reduction method" to describe the flaking processes of microblades without making any assumptions about chronology. Because we emphasize the flow of microblade production, the idea of "microblade reduction method" is close to the concepts of "*chaîne opératoire*" (Sellet 1993) and "behavioral chain" (Schiffer 1975).
2. Yoshizaki (1967) insisted that the assemblages characterized by Horoka type burins made of large blade- and large boat-shaped tools, which were called the "Early Shirataki Culture," preceded the stage with microblade assemblages. The accumulation of research during the last two decades, however, has revealed that assemblages similar to the "Early Shirataki Culture" were often accompanied with the Hirosato type microblade cores, bifacial leaf-shaped points, bifacial stemmed points, and bifacial axes. It is indisputable that these microblade cores and retouched tools belong to the late period of microblade assemblages. Consequently, it is certain that Horoka type burins and large boat-shaped tools also belong to this period.

## REFERENCES

- AKAMATSU, MORIO, GOROU YAMADA, KOICHI MIURA, SHIN'ICHI SHIBATA, AND HIROSHI USHIRO  
1999 Discovery of fossil *Bison* from the inner part of the Funka Bay, Hokkaido, and its significances. *Bulletin of the Historical Museum of Hokkaido* 27:1-8. (In Japanese with English abstract.)
- BAMFORTH, DOUGLAS B., AND PETER BLEED  
1997 Technology, flaked stone technology, and risk, in *Rediscovering Darwin: Evolutionary Theory in Archaeological Explanation*: 109-140, ed. C. M. Barton and B. A. Clark. Arlington, VA: American Anthropological Association.
- BLEED, PETER  
1996 Risk and cost in Japanese microcore technology. *Lithic Technology* 21:95-107.  
2003 Cheap, regular and reliable: Implications of design variation in late Pleistocene Japanese microblade technology, in *Thinking Small*: 95-102, ed. R. Elston and S. Kuhn, *Archaeological Papers of the American Anthropological Association* 12.
- BRANTINGHAM, P. JEFFEREY, JOHN W. OLSEN, JASON A. RECH, AND ANDREI I. KRIVOSHAPKIN  
2000 Raw material quality and prepared core technologies in northeast Asia. *Journal of Archaeological Science* 27:255-271.
- CHEN, CHUN  
1984 The microlithic of China. *Journal of Anthropological Archaeology* 3:79-115.
- DEREV'ANKO, ANATOLIY P.  
1998 *The Paleolithic of Siberia: New Discoveries and Interpretations*. Urbana: University of Illinois Press.
- DEREV'ANKO, ANATOLIY P., AND VITALY E. MEDVEDEV  
1995 The Amour River Basin as one of the earliest centers of ceramics in the Far East, in *International Symposium on the Origin of Ceramics in the Far East*. Sendai: Tohoku Fukushi University.
- ENGARU TOWN BOARD OF EDUCATION AND UNIVERSITY OF TSUKUBA  
1990 *Yubetsu River*. (In Japanese with English abstract.)
- ERIKSEN, BERIT V., AND LAWRENCE G. STRAUS  
1998 *As the World Warmed: Human Adaptations across the Pleistocene/Holocene Boundary*. New York: Pergamon.
- FURANO CITY BOARD OF EDUCATION  
1987 *Higashi-Rokugou 1-2 sites*. (In Japanese.)
- GAMBLE, CLIVE  
1986 *The Paleolithic Settlement of Europe*. Cambridge: Cambridge University Press.

- GOEBEL, TED  
1999 Pleistocene human colonization of Siberian and peopling of the Americas: An ecological approach. *Evolutionary Anthropology* 8: 208–227.
- GOEBEL, TED, AND S. B. SLOBOLDIN  
1999 The colonization of Western Beringia: Technology, ecology and adaptations, in *Ice Age People of North America*: 104–155, ed. Robson Bonnichsen and Karen Turnmire. Corvallis: Oregon State University Press.
- GOEBEL, TED, MICHAEL R. WATERS, I. BUVIT, MICHAEL V. KONSTANTINOV, AND A. V. KONSTANTINOV  
2000 Studenoe-2 and the origins of microblade technologies in the Transbaikal, Siberia. *Antiquity* 74: 567–575.
- HAMILTON, THOMAS D., AND TED GOEBEL  
1999 Late Pleistocene peopling of Alaska, in *Ice Age People of North America*: 156–199, ed. Robson Bonnichsen and Karen L. Turnmire. Corvallis: Oregon State University Press.
- HAYASHI, KENSAKU  
1968 The Fukui microblade technology and its relationship in northeast Asia and North America. *Arctic Anthropology* 5: 128–190.
- HOFFECCKER, JOHN, W. ROGER POWERS, AND TED GOEBEL  
1993 The colonization of Beringia and the peopling of the new world. *Science* 259: 46–53.
- HOKKAIDO BURIED CULTURAL PROPERTY CENTRE  
1985 *Imakane-Town Pirika 1 site*. (In Japanese.)  
1999 *Chitose-City Kashiwadai 1 Site*. (In Japanese.)
- IMAMURA, KEIJI  
1997 *Prehistoric Japan: New Perspectives on Insular East Asia*. London: UCL Press.
- KATOU, SHIGEHIRO  
1994 The age of the En-a pumice-fall deposit and the paleoclimate around its age. *Geographical Review of Japan* 67: 45–54. (In Japanese with English abstract.)
- KATOU, SHIMPEI  
1970 Historical and Regional Characteristics in Pre-ceramic Age, in *Archaeology and Region*, ed. T. Wakamori. Asakura Shoten. (In Japanese.)  
1984 The emergence of the microlithic culture in Japan. *Sundai Historical Review* 60: 38–56. (In Japanese.)
- KELLY, ROBERT L.  
1988 The three sides of a biface. *American Antiquity* 53: 717–734.
- KIMURA, GAKU  
1981 Subduction styles during Cretaceous in Hokkaido, *Science* 55: 24–31. (In Japanese.)  
1985 Tectonic evolution and stress field in the southwestern margin of the Kurile Arc. *Journal of Geological Society of Japan* 87: 757–768. (In Japanese with English abstract.)
- KIMURA, HIDEAKI  
1992 Reexamination of the Yubetsu technique and study of the Horokazawa Toma lithic culture. Sapporo University Press. (In Japanese and English.)
- KOBAYASHI, TATSUO  
1970 Microblade industries in Japanese archipelago. *Arctic Anthropology* 2: 38–58.
- KUHN, STEVEN L.  
1994 A formal approach to the design and assembly of mobile toolkits. *American Antiquity* 59: 426–442.
- MATSUI HIROYUKI, RYUJI TADA, AND TADAMICHI OHBA  
1998 Low-salinity isolation event in the Japan Sea in response to eustatic sea-level drop during LGM: Reconstruction based on salinity-balance model. *Quaternary Research* 37: 221–233. (In Japanese with English abstract.)
- MIURA, HIDEKI, AND KAZUOMI HIRAKAWA  
1995 Origin of fossil periglacial wedges in northern and eastern Hokkaido, Japan, *Journal of Geological Society of Japan* 104: 189–224. (In Japanese with English abstract.)
- MORLAN, RICHARD E.  
1967 The pre-ceramic period of Hokkaido: An outline. *Arctic Anthropology* 4: 164–220.

- NAKAMOTO SITE RESEARCH GROUP  
In press *Nakamoto site*. (In Japanese.)
- NELSON, MARGARET C.  
1991 The study of technological organization. *Archaeological Method and Theory* 3:57–100.
- OBA, TOSHIO, YUKOU KONDO, AND HIROAKI MIYA  
1983 Yoshiizawa Site. *Bulletin of the Kitami City Museum* 13:1–37. (In Japanese.)
- OBIHIRO CITY BOARD OF EDUCATION  
1986 *Obihiro Akatsuki Site 2*. (In Japanese.)
- OKUMURA, KOUJI  
1991 Quaternary tephra studies in the Hokkaido district, northern Japan. *Quaternary Research* 30:379–390. (In Japanese with English abstract.)
- ONO, YUGO  
1990 The northern land bridge of Japan. *Quaternary Research* 29:183–192. (In Japanese with English abstract.)
- ONO, YUGO, AND TOSHIRO NARUSE  
1997 Snowline elevation and eolian dust flux in the Japanese islands during isotope stage 2 and 4. *Quaternary International* 37:45–54.
- SATOU, HIROYUKI  
2003 The early Upper Paleolithic in Hokkaido. *Cultura Antiqua* 55(4):3–16. (In Japanese.)
- SCHIFFER, MICHAEL BRIAN  
1975 Behavioral chain analysis: Activities, organization, and the use of space. *Chapters in the Prehistory of Eastern Arizona, IV Fieldiana: Anthropology*: 103–119. Chicago: Field Museum of Natural History.
- SELLET, FRÉDÉRIC  
1993 *Chaîne opératoire*; the concept and its application. *Lithic Technology* 18:106–112.
- SEONG, CHUNTAEK  
1998 Microblade technology in Korea and adjacent northeast Asia. *Asian Perspectives* 37:245–278.
- SHIGA, KENJI, AND ITARU KOIZUMI  
2000 Latest Quaternary oceanographic changes in the Okhotsk Sea based on diatom records. *Marine Micropaleontology* 38:91–117.
- SHIMADA, KAZUTAKA, AND AKIRA YAMASHINA  
1998 Reexamination and reestimation of the Paleolithic materials kept in the Archaeological Museum of Meiji University. *Study Report of the Museum of Meiji University* 3:23–67. (In Japanese.)
- SHIMAKI SITE EXCAVATION GROUP, UNIVERSITY OF TSUKUBA  
1988 The lithic culture of Shimaki Site in Kamishihoro Town, Katou County, Hokkaido. *Bulletin of the Faculty of History and Anthropology* 16:279–340. (In Japanese.)
- STRAUS, LAWRENCE G.  
1991 Human geography of the late Upper Paleolithic in Western Europe: Present state of the question. *Journal of Anthropological Research* 47:259–278.
- STRAUS, LAWRENCE G., BERIT V. ERIKSEN, JOHN M. ERLANDSON, AND DAVID R. YESNER  
1996 *Humans at the End of the Ice Age: The Archaeology of the Pleistocene and Holocene Transition*. New York: Plenum Press.
- TAKAKURA, JUN  
2000 Reconsideration of the microblade assemblage at Yoshiizawa B Site, Kitami City, Hokkaido. *Journal of Hokkaido Paleolithic Research* 5:1–34. (In Japanese.)
- TERASAKI, YASUFUMI  
1999 Microblade industries in Hokkaido: A preliminary discussion. *Bulletin of Prehistoric Archaeological Studies* 8:71–88. (In Japanese.)
- TORRENCE, ROBIN  
1989 Re-tooling: Towards a behavioral theory of stone tools, in *Time, Energy, and Stone Tools*: 57–66, ed. R. Torrence. Cambridge: Cambridge University Press.



TSURUMARU, TOSHIAKI

1979 The microlithic cultures in Hokkaido district. *Sundai Histirical Review* 47:23–50. (In Japanese.)

VELICH'KO, ANDREJ A., AND E. I. KURENKOVA

1990 Environmental conditions and human occupation of northern Eurasia during the late Valdai, in *The World at 18,000 B.P., Volume 1*: 255–265, ed. Olga Soffer and Clive Gamble. London: Unwin Hyman.

YOSHIZAKI, MASAKAZU

1967 On the Japanese from Archaeological perspectives. *Genetics* 21(1):14–18. (In Japanese.)

#### ABSTRACT

Five decades of research history on the late Upper Paleolithic in Hokkaido (northern Japan) shows that microblade assemblages appeared by approximately 20,000 B.P. and that various microblade technologies were developed during late Pleistocene. The empirically observed good association between the morphological features of lithic raw materials and the reduction sequences of microblade cores demonstrates that morphological features of procured lithic raw materials (i.e., size and surface condition), which were constrained by unique geological and geoarchaeological characteristics in Hokkaido, created remarkable variability in reduction methods of microblade technology. This implies that geoarchaeological perspective can contribute to understanding technological variability in microblade assemblages in northeastern Asia. **KEYWORDS:** Hokkaido, microblade, technological variability, geoarchaeology, oxygen isotope stage 2.